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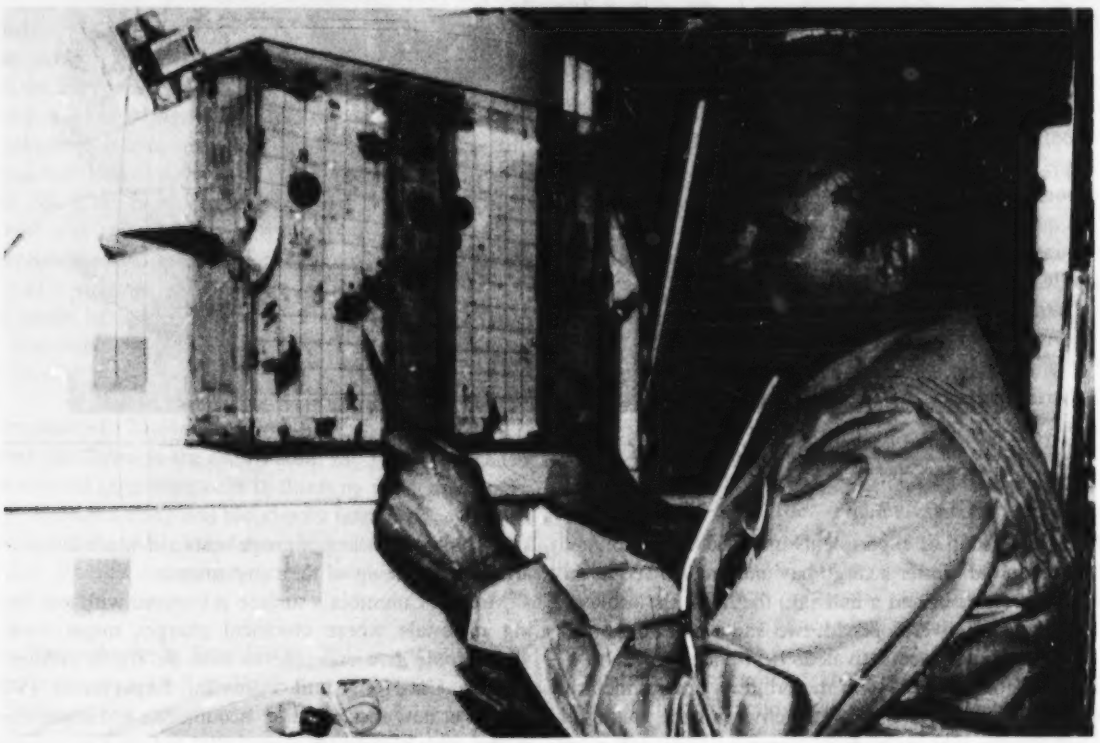
NASA National Aeronautics and Space Administration

Report To Educators

Vol. 10, No. 1 Spring 1982



Insects in Flight Motion Study, a student experiment aboard the Columbia, being studied by astronaut Jack Lousma.

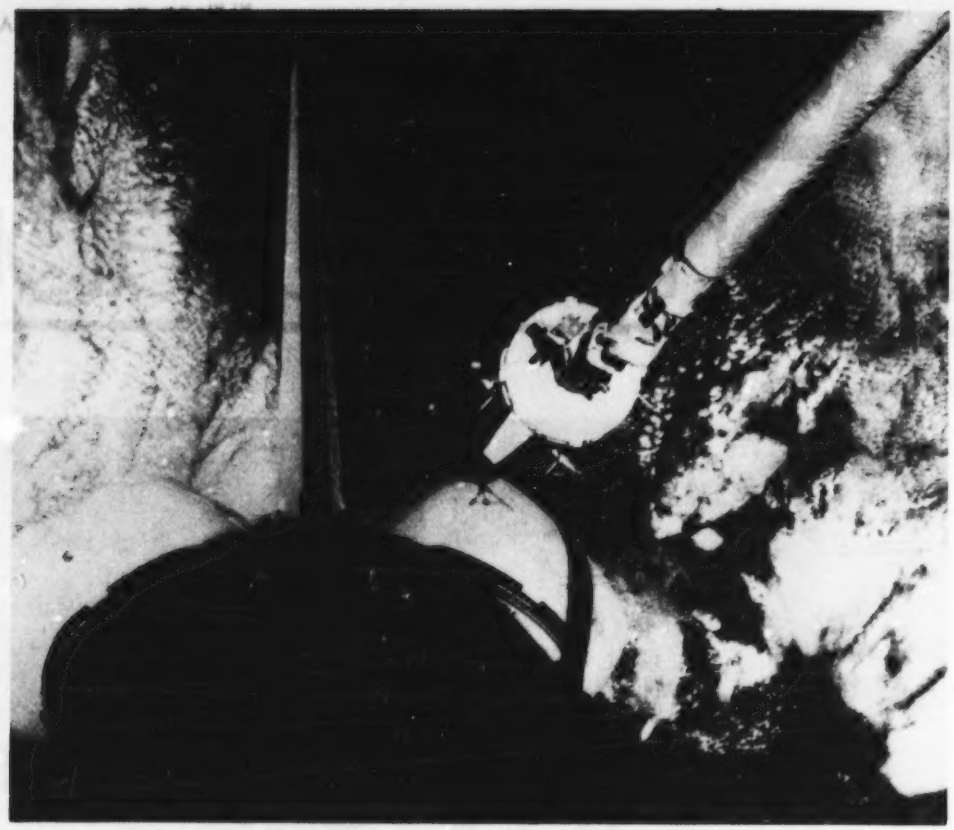
Onboard STS-3

During the Space Shuttle Columbia's third flight, the crew—Jack R. Lousma, commander, and C. Gordon Fullerton, pilot—had a full schedule of scientific experiments and orbiter tests to perform. The Space Transportation System's mission (STS-3) was another verification of the Shuttle's capability to do the job it was designed to do, haul heavy payloads into and out of Earth orbit with a reusable vehicle.

There were thermal tests of the orbiter, the first Office of Space Science experiments package (OSS-1), a Getaway Special canister, and a Shuttle Student Involvement Project (SSIP) experiment. Still photography recorded many of the activities, motion pictures were taken of others, and television relayed daily reports.

Insects in Flight Motion Study. During the 38th orbit astronaut Lousma attached a container that housed colonies of Velvetbean Caterpillar Moths, Honeybee Drones, and houseflies to one of the Columbia's mid-deck walls. The experiment, designed by Todd Nelson, a high school senior from Minnesota, was a study of the different insects' adaptation to the low-gravity of Earth orbit. He chose the insects for the difference between their mass and wing surface areas and their ready availability. Lousma's initial descriptions noted that the bees were tumbling, the flies walking on the surface of the container, and the moths flying.

NAS 1. 49:



The Plasma Diagnostics Package, looking like a tiny satellite, in the grasp of the Remote Manipulator Arm above the Columbia's cargo bay.

OSS-1. This group of experiments included eight mounted on a pallet in the orbiter's cargo bay and one stowed in the crew cabin. An hour and a half into the flight the orbiter's payload bay doors were opened; two and a half hours later the OSS-1 package was activated. It provided a wealth of information for scientists—on the orbiter's environment in space, how its presence changes the environment, studies of the Sun, and, in a miniature terrarium, the effect of weightlessness on lignin, the woody substance in plants.

The **Plasma Diagnostic Package (PDP)** was designed to study the interaction of the Columbia with its environment in space, how the orbiter affects the electromagnetic fields as it moves through the ionosphere and the electrical fields that the spacecraft itself generates.

The PDP was also the first real test for the Canadian-built Remote Manipulator System, the robot arm. The tv camera on the "wrist" of the mechanical arm failed, but the crew were able to guide it visually through its maneuvers to grapple the instrument package, lift it, and move it freely out of the cargo bay.

Another experiment, the **Shuttle-Spacelab Induced Atmosphere Experiment (SSIA)** measured the optical properties of the orbiter's "atmosphere." Scientists need to know how outgassing of propellants and water dumps might affect the viewing of their instruments.

Most of Columbia's surface is covered with nonconducting materials where electrical charges might build up, which could give experiments false electrical readings. The **Vehicle Charging and Potential Experiment (VCAP)** looked at how these charges accumulate and cause changes in the orbiter's electrical potential (voltage relative to the surrounding ionosphere).

A **Microbrâsion Foil Experiment** was designed to trap any micrometeoroids that might strike foil-covered sensor panels in the cargo bay. Back on Earth scientists are measuring the size and shape of craters made on the foil and any captured particles. Also in the cargo bay was a **Contamination Monitor Package** to monitor the buildup of volatile materials inside the cargo bay during launch, orbital operations, and landing; the data is being correlated with Shuttle and Payload Operations and with the OSS-1 instruments' performance. Another important cargo bay experiment was the **Thermal Canister Experiment (TCE)** designed to see if the technology of heat pipes can control temperatures effectively for experiments exposed to the space environment.

OSS-1 included two solar experiments. One, the **Solar Flare X-Ray Polarimeter Experiment (SFXP)** may increase our understanding of the physical processes that drive solar flares. Using three separate observation stations for cross-referenced results, SFXP studied the polarization of x-rays emitted during a solar flare, and looked for direct evidence for the theory that electron beaming occurs in flares. The second, a **Solar Ultraviolet Spectral Irradiance Monitor (SUSIM)** aimed to improve the accuracy of measurements of far-ultraviolet radiation streaming from the Sun. Because experiments facing the Sun can get "sunburned" from the intense illumination striking a possible layer of contaminant film, SUSIM contained two observing stations—one for making constant observations and the other for occasionally checking to see if the first was blinded.

The ninth OSS experiment, a miniature greenhouse called the **Plant Growth Unit,** was in the crew cabin. The quantity and rate of lignin formation (the woody substance that allows plants to grow upward and gives them their shapes) was tested with slash pine, mung bean, and oat plants. Six 25cm plant growth chambers carried 96 plants. The unit was automatic, requiring the crew only to relay temperature data to scientists at the Johnson Space Center (JSC) so conditions with the control group of plants on Earth would be similar. The results of this first study will help determine the choice of plants to fly under similar conditions aboard the Spacelab in 1984.

Electrophoresis Equipment Verification Test (EEVT). Another test flown in the crew cabin, the EEVT evaluated the process of separating cells in fluids by using an electric charge. Human kidney and blood cells were used in the test and the results will help determine the feasibility of purifying biological materials in the low gravity environment of space.

Heflex Bioengineering Test (HBT). This test was a repeat of one flown on STS-2 in November 1981. Because the STS-2 mission was cut short, the first test was incomplete. The Heflex (Helianthus Annuus Flight Experiment) was a package of sealed containers of dwarf sunflower seedlings in soils of varying moisture content to establish a relationship between the soil moisture and seedling growth in weightlessness.

Getaway Special. A test canister was flown to verify its suitability as a container for Getaway Specials, low-cost scientific and research experiments. The self-contained payloads are developed by educational organizations, industry, and individuals and will be scheduled for flight on a space-available basis.

Monodisperse Latex Reactor (MLR). A materials-processing experiment that could benefit medical research, the monodisperse (identical size) latex reactor was designed to see if latex spheres larger than two microns could be produced in low gravity. The experiment will be carried on four Shuttle flights.

The Orbiter. The Columbia itself was the subject of thermal experiments: for 28 hours the tail was pointed toward the Sun; for 80 hours, the nose towards the Sun; and for 28 hours, the payload bay toward the Sun while the orbiter held an inertial attitude. The bulk of the data gathered by the OSS-1 payload was during the inertial payload-bay-toward-Sun attitude.

The Flight. The experiments were part of a busy flight that began just an hour behind schedule. Columbia was launched at 11 a.m. EST on March 22, and again the rocket engines and myriad of systems that are the complicated STS performed flawlessly. Some protective heat tiles were lost during launch, but none critical for entry. Space sickness, a balky toilet, control and radio static that interfered with sleep, and a malfunctioning thermostat marred the early days of the flight. But with most of the problems corrected by the third day, the crew concluded their mission with tasks completed and high praise for their spaceship.

Landing was scheduled for March 29 on Rogers Dry Lake at the Dryden Flight Research Facility in California. However, heavy rains in mid-March made the lake bed a questionable landing site for that date. Northrup Strip at the White Sands Missile Range in New Mexico was substituted, and two special trains with 38 railroad cars transported the necessary supplies and equipment. On March 29 high winds caused a severe sandstorm preventing the landing and the flight was extended another day.

It was eight days, four minutes, and 49 seconds after lift-off that Columbia landed. Longest of the Shuttle test missions—129 orbits, over five million kilometers traveled—STS-3 was a success and the Space Shuttle another flight closer to becoming operational.

Educators' Conferences. Three conferences for educators were held in conjunction with STS-3. One group met at the Kennedy Space Center, March 21-22, for a program that included discussions of the STS-3 Vehicle and Mission Profile, OSS-1 Payload, and SSIP. Concurrently, a group of university research coordinators from 50 institutions in 23 states, were briefed on Current and Future Programs in Space Science and Applications and in Aeronautics, the CLASS program, and NASA's policies and regulations relating to universities. James M. Beggs, NASA's administrator, addressed the participants of the conferences, who also toured the Center and witnessed the STS-3 launch.

The following day, March 23, a third conference was held at JSC. Some 80 attendees met with student-experimenter Todd Nelson, the Deputy Manager of the Orbiter Project Office, and an OSS-1 mission scientist from the Goddard Space Flight Center. Other highlights were visits to the Mission Operations Control Room, Space

Environment Simulation Laboratory, and the l-g Trainer, and lunch with an astronaut.

STS-4. June 27 is the scheduled launch date for STS-4, the last of four orbital flight test missions. The crew will be Thomas K. Mattingly, commander, and Henry W. Hartsfield, pilot.

Pioneer X's Tenth Anniversary

Pioneer X, now making the first trip out of the solar system, completed ten years in space on March 2, 1982.

Since launch in 1972, the spacecraft has compiled an impressive list of achievements. In addition to being the first spacecraft to Jupiter, it was the first to cross the asteroid belt; confirmed that Jupiter is a liquid planet; made the first measurement of Jupiter's huge magnetosphere and powerful radiation belts; made the first accurate measurements of mass and densities of Jupiter's planet-sized moons; sent back the first closeup pictures of Jupiter's Great Red Spot and the belts and zones showing details of atmosphere circulation; and provided the resolution of the controversy about the origin of the gegenschein and zodiacal light in interplanetary space.

Pioneer has operated almost without flaw, has traveled over 6.6 billion kilometers, received more than 40,000 commands from Earth, and returned more than 125 billion bits of scientific data. It is now more than half way between the orbits of Uranus and Neptune, 4.6 billion kilometers from the Sun. In April 1983 Pioneer will be farther from the Sun than the planet Pluto. By June 1983 it will be farther out than Neptune—outside all of the planets of the solar system, in their current positions. (Pluto's orbit is so elongated that the "outermost" planet will be inside Neptune's orbit for the next 17 years.)

NASA officials have selected October 1986, when Pioneer crosses the mean orbit of Pluto, as the official date for the first spacecraft's leaving the solar system. Pioneer will cross the farthest extension of Pluto's orbit in April 1989.

On its tenth anniversary Pioneer was 4.6 billion kilometers distant; it took three hours and 42 minutes for spacecraft data, traveling at the speed of light, to reach the Pioneer Operations Center at NASA's Ames Research Center (ARC). This communication time has been lengthening at a rate of one minute every four days.

Despite ten years of continuous operation, damage from intense Jovian radiation, and hits by tiny micrometeoroids, almost all Pioneer's systems are performing well. The magnetometer ceased to function in 1975, but experimenters can calculate the interplanetary field from charged particle trajectories, magnetic data already gathered, and correlations from five other of its scientific instruments.

From Pioneer's current distance, the Earth would be seen as a pin point of light, never more than 2.2 degrees away from a Sun still intensely bright, but no larger than a pinhead. Because of this vast distance and the decline in brightness of the Sun, its Sun sensor will not be able much longer to provide the Sun pulse, which gives rotational position of the spinning spacecraft several times a minute. However, mission controllers at ARC have devised, and will soon be using, a method of making star maps with the Pioneer camera (imaging photopolarimeter) to provide the needed rotational and attitude data.

As it travels out to the edge of the solar system, Pioneer is engaged in a new mission—defining the extent and behavior of the Sun's atmosphere, the magnetic bubble that contains the solar system, called the heliosphere. The Sun is the only star that can be measured close up, and finding the extent and dynamics of its atmosphere will tell a great deal about the Sun itself, the interstellar gas surrounding the solar system, and thus about stars in general.

Pioneer is defining a picture that shows that the heliosphere (created by the solar wind, blowing out from the Sun in all directions) is far larger than predicted and appears to be tear-shaped. The magnetic bubble is "stream-lined" by the motion of the solar system through the interstellar gas. Pioneer is traveling "down the tail" of the heliosphere teardrop, seeking the boundary between the Sun's atmosphere and true interstellar space. No one knows, but scientists think this boundary region may lie between 9.25 and 18.5 billion kilometers from the Sun. NASA's Deep Space Network expects to be able to track Pioneer out to somewhere beyond 9.25 billion kilometers.

While it continues to set new distance records, Pioneer also continues to make new discoveries. Recent findings about the heliosphere: **1** The heliosphere bubble "breathes" in and out once every 11-year solar cycle. **2** As solar storm activity builds up, the heliosphere is believed to change into a more oval shape lined up with the Sun's equator, from its rounder shape at solar minimum; it also may expand in size. **3** The solar wind was expected to slow with distance from the Sun, but this has not happened; almost no motion energy has been lost as heat. **4** The primary source of turbulence in the outer heliosphere is storms on the Sun. **5** Near solar maximum, cosmic ray particles incoming from the galaxy in all velocity ranges (even near light speed) are reduced by one half or are shut out completely from the heliosphere by the expanding pressure of the solar wind. **6** For unexplained reasons, high velocity streams of electrons from Jupiter moving through the heliosphere do not wobble as expected from the planet's axial tilt.

Scientists watch Pioneer's trip with great excitement. Dr. Aaron Barnes, astrophysicist at ARC, says "It's hard to overstate the interest of the physics coming out of this phase of the Pioneer mission. We are constantly entering unexplored territory, and we really don't know what we'll learn about our local star."

Urban Community Enrichment Program (UCEP)

This spring, students in 14 Memphis, Tennessee, schools participated in an aerospace adventure in learning. They, their teachers, and their school administrators were introduced to a variety of subjects and activities designed to stimulate their learning through an involvement in aerospace education programs.

The Memphis students were sharing an Urban Community Enrichment Program (UCEP), a project that focuses on middle level schools. The program begins with a workshop for interested teachers to provide them with resource information and classroom activities and the students hear a lecture-demonstration that gives them an overview of NASA's programs. Then, for six to eight weeks, selected groups of students learn about activities such as model-building, science fair projects, and the Shuttle Student Involvement Project, and are given opportunities to organize special interest clubs.

STS-3 offered the Memphis students something extra. Through a teleconference from the Kennedy Space Center to Memphis where the students had been bused to a central location, the President of the Memphis School Board, in attendance at Columbia's third launch, described the event for the youngsters.

UCEP grew out of an October 1980 conference jointly sponsored by NASA and the Federal Aviation Administration at Howard University in Washington, DC. Called "Learning through Aviation and Space Education," more than 50 school officials from large urban school districts attended to become acquainted with aerospace education activities that have successfully motivated students to both learning and career planning. Six months later the UCEP project was initiated in 12 Washington, DC, schools. Other programs followed in Baltimore, Maryland, and Gary, Indiana.

UCEP is under the general direction of **Roscoe Monroe,** Community Services Officer in the Education Services Branch at NASA Headquarters.

District of Columbia students building models during a UCEP activity program in Washington.

CLASS Program

In October 1981 NASA's Education Services Branch introduced a new education program to bring a better understanding of the agency's research and development activities to college and university engineering and science students.

The program, called CLASS for College Lecturers on Aeronautics and Space Sciences, is designed to (1) provide in-depth discussions of NASA's current research projects and objectives, (2) create an awareness of its aeronautics and space science programs, (3) point out career opportunities in the aerospace field, and (4) distribute up-to-date materials related to current aerospace research.

At present there are four lecturers in the CLASS program with expertise in biology, physics, engineering, and science education. Their on-campus schedules include colloquia or classes for science and engineering students, faculty seminars, lectures for the student body, meetings with campus chapters of professional organizations. Each program is enhanced with a variety of audiovisual materials; informal meetings with students and faculty offer information on aerospace careers, graduate programs in aeronautics and astronautics, and NASA's post-doctoral and visiting scientist programs.

During the first six months of CLASS, the specialists lectured at 31 universities in 11 states before audiences totaling more than 11,000 faculty and students. They also made numerous television and radio appearances.

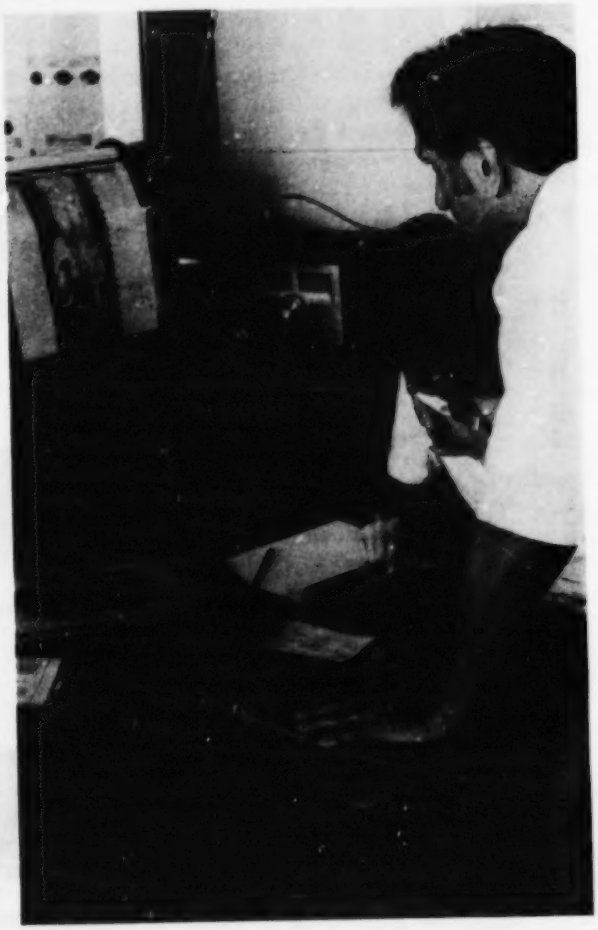
Larry Bilbrough of the Education Services Branch at NASA Headquarters has program responsibility for CLASS.

Teachers' Guide for Building and Operating Weather Satellite Ground Stations

Classroom experiences at the Chambersburg (PA) Area Senior High School provided the impetus for this new publication written by R. Joe Summers and Timothy Gotwald of the school faculty. Published for high school science teachers by the Educational Programs Branch at NASA's Goddard Space Flight Center, the *Teachers' Guide for Building and Operating Weather Satellite Ground Stations* presents a unique combination of aerospace research, technology, and applications. It not only gives an insight into some of the excitement generated by the science and technology of the space program, but also may serve as a springboard for career ideas.

Title chapters include Weather Satellite Automatic Picture Transmission System, Printing Satellite Pictures, Use of Direct Readout Stations, and Weather Satellite Products in Science Education; other chapters describe a station, radio receivers, recording and reproduction of satellite pictures. There are also references, suggested reading, and a glossary.

Single copies of the guide may be obtained by writing to Mr. Elva Bailey, Educational Programs Officer, NASA Goddard Space Flight Center (202.3), Greenbelt, MD 20771. The office will welcome your comments on how you use the guide.



Telelecture

NASA's Langley Research Center (LaRC) offers educators a special service with its telelecture program, a slide lecture presented to groups via a telephone with an amplifying device. The audience may be thousands of miles away, but the pre-shipment of slides and the conference-style telephone connection allow opportunities for audience response and questions.

Eight topics are available for audiences from the fourth grade up: "NASA and Energy," "Flying Machines," "Exploration of the Solar System," "Space Shuttle," "Manned Spaceflight," "Satellites at Work," "Voyage to the Outer Planets," and "Large Space Systems: 1990 and Beyond." Any school or special interest group may book a telelecture program, which usually lasts an hour. NASA provides the slides and lecturer; the requesting group provides a 35mm carousel slide projector and screen and arranges for the amplifying system for their telephone.

For college and university classrooms, 11 Technical Papers that LaRC authors have presented to various professional societies have been prepared as telelectures. These lectures are 30 minutes in length after which time is allowed for discussion and questions from the audience.

To schedule a telelecture or for more information about any of the programs, contact Renee Benton, Head, Langley Telelecture Program, Office of Public Services, NASA Langley Research Center (MS 150), Hampton VA 23665. Phone: 804/827-3966.

Career Information

The *Careers in Aerospace* series published in 1980 has been updated and expanded to 15 aerospace career profiles. Each profile includes a description of the work performed, qualifications needed, preparation and training, job prospects, related fields, and sources of additional information. The titles: *Aerospace Craftsperson* (PAM-134), *Aerospace Engineer* (PAM-135), *Aerospace Engineering Technician* (PAM-136), *Astronomer* (PAM-137), *Electronics Engineer* (PAM-138), *Geographer* (PAM-139), *Geologist* (PAM-140), *Ground Radio Operators and Teletypists* (PAM-141), *Mathematician* (PAM-142), *Meteorologist* (PAM-143), *Patternmaker and Molder* (PAM-144), *Physicist* (PAM-145), *Science Writer* (PAM-146), *Systems Analyst* (PAM-147), and *Test and Research Engineer* (PAM-148).

The publications are available from the NASA educational office serving your state (see p.8).

Index to NASA's Astronomy Books

The Astronomical Society of the Pacific has compiled *A Brief Subject Index for N.A.S.A.'s Special Publications Relating to Astronomy*. Among the books listed are nontechnical descriptions of the most recent missions to Mars, Jupiter, and Saturn, and summaries of conferences concerning the search for extraterrestrial life and the buildup of space habitats. Specific addresses and telephone numbers for ordering the publications are also included.

To receive a copy of the index, send two first-class postage stamps with your name and address, including ZIP code, to: NASA Index, Astronomical Society of the Pacific, 1290 24th Avenue, San Francisco, CA 94122.

New NASA Publication

A Meeting with the Universe, Science Discoveries from the Space Program, EP-177, is the story of what we have learned about the universe and ourselves by going into space. From the preface: "It is not a textbook for scientists. It is written for everyone who shared the excitement and wonders of the last few years—students, teachers, scientists, engineers, other professional people, and curious citizens of all kinds. It is not a NASA history. It is a history of space exploration. . . ."

The story is told in seven sections—The Climb into Space, The New Worlds, The Sun and Earth in Space, Beyond the Solar System, The Human Element, Life in the Universe, The Long Climb Ahead—followed by an Appendix. Hardcover, illustrated, 221 pp. $14.00. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Mailing List Purge

By government regulation, we may retain names on our mailing list for a limited time only unless the addressees indicate a wish to receive further mailings. We also are limited to a list of 55,000 names, which has grown beyond that total.

To comply with these regulations and to eliminate the current labels that are being returned marked "Addressee Unknown," NASA's Education Services Branch will conduct a mailing list purge at the start of the 1982-83 academic year. To maintain your name on the list, it will be necessary to fill out and return a special card that will be mailed to you in September. Watch for the "Educators' Mailing List" verification card in the mail and return it to NASA immediately.

Where to Write for Services

NASA publications should be ordered from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Publication lists, film lists, and information about other services are available from the Educational Office at the NASA center serving your state. See the list below. There are special resource centers for educators at the Kennedy Space Center, Lewis Research Center, and Alabama Space and Rocket Center, Huntsville, AL.

NASA Ames Research Center
Moffet Field, California 94035
Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

NASA Lyndon B. Johnson Space Center
Houston, Texas 77058
Colorado, Kansas, Nebraska, New Mexico, N. Dakota, Oklahoma, S. Dakota, Texas

NASA John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
Florida, Georgia, Puerto Rico, Virgin Islands

NASA Langley Research Center
Hampton, Virginia 23665
Kentucky, N. Carolina, S. Carolina, Virginia, West Virginia

NASA Lewis Research Center
21000 Brookpark Road, Cleveland, Ohio 44135
Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

NASA George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, Tennessee

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The Administrator of the National Aeronautics and Space Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through December 31, 1981.

NASA REPORT TO EDUCATORS is published four times per year for the community of educators. Recommendations are solicited from readers, and should be addressed to the Education Services Branch, Academic Affairs Division (LCG-9), National Aeronautics and Space Administration, Washington, DC 20546. Photocopying for school use is approved.

Muriel M. Thorne, Editor

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NASA Report to Educators

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NASA National Aeronautics and Space Administration

Report To Educators

Vol. 10, No. 2 Summer 1982

The Shuttle's Last Test

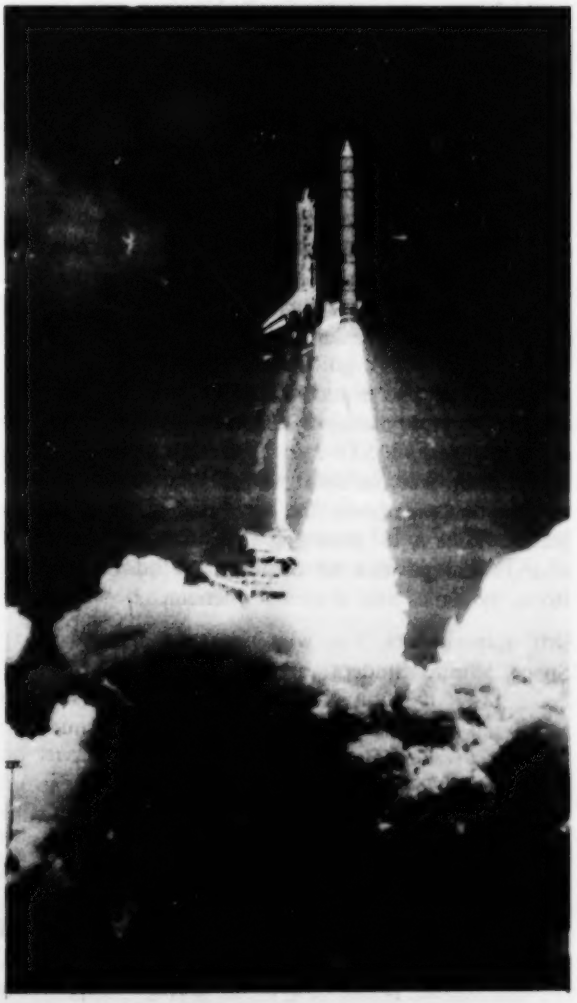
The routine that space flight can be was the excitement of STS-4, the Space Transportation System's fourth and final test flight. The flawless, on-time liftoff, the lack of serious onboard problems, the textbook landing, pronounced the Space Shuttle an operational, reusable spacecraft. Regular flights would begin with STS-5.

The STS-4 mission lasted seven days, one hour, and nine minutes. It began at 11 a.m. EDT, June 27, at the Kennedy Space Center in Florida. It ended on July 4 at 12:09 p.m. EDT on a concrete runway at Edwards Air Force Base in California. The Columbia and its crew—Thomas K. Mattingly II, commander, and Henry W. Hartsfield, Jr., pilot—were greeted by President and Mrs. Reagan and an exultant crowd of 500,000. An international TV audience shared their success.

The Orbiter. STS-4, like the preceding three missions, was an engineering test flight to prove out the Shuttle system in launch, orbital, and landing operations. Again, the orbiter was a priority. To conduct thermal experiments, it was scheduled to fly in different modes—tail to Sun, bottom to Sun, and payload bay to Sun—for varying periods of time. However, its surface-tiles were water-soaked by a severe storm before launch, so the Columbia was flown for a long period with its underside to the Sun to dry the tiles. During that time, the payload bay doors were exposed to severe cold and, when tested, one door did not close. The problem was corrected by putting Columbia in the "barbecue" mode, rotating the spacecraft to heat it evenly.

Other tests collected aerodynamic data as well as additional thermal data to improve the protection system.

Experiments. Some scientific experiments were being flown for the first time, others for a second; there was one from the private sector, a first by a commercial concern, several by students, and one classified payload for the Department of Defense.



A new look for the STS. STS-3 and STS-4 lifted off looking different from the first two flights. The External Tank, largest element of the Shuttle, was a dark peach color instead of white. The peach (also described as apricot and light brown) is the natural color of the spray-on foam insulation used on the tank exterior. By leaving off the white paint that was added to the STS-1 and STS-2 tanks, almost 272 kgs of extra Shuttle payload capability is realized.

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The *Continuous Flow Electrophoresis System (CFES)*, was part of a NASA-McDonnell Douglas Astronautics Co. joint endeavor agreement to conduct research in space. The experiment involves separation of proteins and other biological materials according to their surface electrical charge as they pass through an electric field in a continuous stream. This initial flight was an engineering test of the electrophoresis hardware, and the experiment processed the separation of six protein samples. McDonnell Douglas designed the experiment and conducted it in collaboration with scientists of the Ortho Pharmaceutical Division of Johnson & Johnson Co. Its success will foster its potential for the manufacture of pharmaceuticals in space.

Another applications experiment was the second flight of the *Monodisperse Latex Reactor (MLR)*, a materials processing experiment. Scheduled for four Shuttle flights, the MLR will see if microgravity improves the production of a large-size monodisperse (identical size) latex. On STS-3 the latex particles ranged up to 5 microns in diameter; the largest were used as "seed" for STS-4 to produce new latex particles of larger diameters. These in turn will be used on the next space test, when scientists hope to grow particles up to 20-25 microns across. Latexes with large diameters could have important industrial and medical applications.

STS-4 was also the second flight for the *Nighttime/Daytime Optical Survey of Lightning (NOSL)* experiment that flew on STS-2 in November 1981. Because that mission was cut short, very little data was gathered. For this experiment the crew used a 16mm motion picture camera to photograph lightning storms from their orbital position to acquire new information on storm dynamics and electrical phenomena.

SSIP Experiments. Two winning entries from the first Space Shuttle Student Involvement Project (SSIP) competition flew on STS-4. Both projects used the astronauts as test subjects for life sciences experiments.

The Effects of Diet, Exercise, and Zero Gravity on Lipoprotein Profiles by Amy Kusske, a 16-year-old student of Wilson High School, Long Beach, CA, documented the astronauts' diet and exercise program to determine whether any alterations occur in lipoprotein profiles during spaceflight. This ratio is related to cholesterol plaque accumulation in the arteries and a change in it increases the probability of heart attack. *The Effects of Space Travel on Levels of Trivalent Chromium on the Body* was designed by Karla Hauersperger, a 17-year-old student of East Mecklenburg High School, Charlotte, NC; trivalent chromium is a factor in carbohydrate metabolism.

The projects used results of an analysis of the crew's blood and urine samples collected in pre- and postflight physicals. The samples were analyzed at the Johnson Space Center's Biomedical Laboratories and the results provided to the students for interpretation. During the mission, the crew filled out log cards for the students each day, recording their exercise performance and how much of what foods they ate.

Each student had a corporate sponsor: Ms. Kusske, McDonnell Douglas Astronautics Co., and Ms. Hauersperger, the Explorer's Club of New York City.

Getaway Special. The first operational Getaway Special flew on STS-4. The 61 × 91cm canister held nine experiments designed by Utah State University students. One of STS-4's minor glitches concerned a defective circuit that prevented electrical power from reaching the Getaway Special. On the fourth day, the crew successfully by-passed the troublesome circuit to the delight of the anxious students.

The experiments *Drosophilia Melanogaster (Fruit Fly) Growth Experiment*, designed to raise succeeding generations of fruit flies in orbit to study the effects of microgravity on their genetic structure, tested equipment that is proposed to be flown on the Long Duration Exposure Facility. Other microgravity experiments were: *Artemia (Brine Shrimp) Growth Experiment* to determine genetic effects on cysts hatched in space; *Surface Tension Experiment* to study the shape of a meniscus (the curved upper surface of liquid in a container); *Composite Curing Experiment* to complete the cure of a B-staged (partially cured) epoxy resin-graphite composite sample; *Microgravity Soldering Experiment* to study the separation of flux from solder; *Root Growth of Lemna Minor L. (Duckweed) Experiment* to photograph the plant's root growth patterns to investigate nutrient transport in the roots; and *Algal Microgravity Bioassay Experiment* to study the growth rate of a one-celled green algae. The *Thermal Conductivity Experiment* mixed oil and water, then heated the mixture with a platinum wire; temperatures of all elements were monitored and the thermal conductivity of the mixture will be calculated from the data. The *Homogeneous Alloy Experiment* was housed in an aluminum chamber containing a powdered bismuth-tin mixture, which was heated to allow alloying to take place.

Getaway Specials are available to industry, educational organizations, and domestic and foreign governments for legitimate scientific purposes. This first-to-fly Getaway Special was purchased by R. Gilbert Moore of Ogden, UT, and donated to the university. More than 350 other reservations have been made by over 191 individuals and groups from 33 states, the District of Columbia, and 14 foreign nations. There are no stringent requirements to qualify for spaceflight, but the payload does have to meet safety criteria and have a scientific or technological objective.

The Lost Boosters. The mission was not without a major mishap. Because their main parachutes failed to deploy, the two solid rocket boosters that are designed to be recovered after launch sank in the Atlantic Ocean.

In July, a small remote-controlled submarine called SCARAB 2 (Submersible Craft Assisting Cable Repair), equipped with sonar sensing devices, TV cameras, and mechanical arms, located the boosters on the ocean floor; its cameras sent pictures to the surface and mapped the sites where the boosters lie. NASA will attempt salvage of some parts of the boosters which were broken up by the force of the water impact. One section found intact contains the flight recorder and other electronic equipment that will help determine the cause of the malfunction.

Educators' Conferences. Conferences for educators were held at both launch (Kennedy Space Center) and landing (Jet Propulsion Laboratory). On June 26-27, KSC and Rollins College welcomed over 150 teachers and administrators for a tour of the Center and a program that included discussions of the STS-4 Vehicle and Mission Profile, a description of the flight's Getaway Special, an address by astronaut **Michael J. Smith,** and talks by the teachers of the two SSIP students whose experiments were on STS-4. On June 27 the group was at the on-Center viewing site for the launch.

Seven days later, on July 3, the Ames Research Center, Dryden Flight Research Facility-ARC, and Jet Propulsion Laboratory hosted Space Shuttle Landing #4 Conference. Some 300 participants heard talks on Shuttle Imaging Radar-A Results, the Shuttle Industry Point of View, the student projects onboard STS-4, and a discussion of the STS by astronaut **Owen K. Garriott,** Mission Specialist for STS-9. On July 4th the group joined the throng who witnessed Columbia's landing.

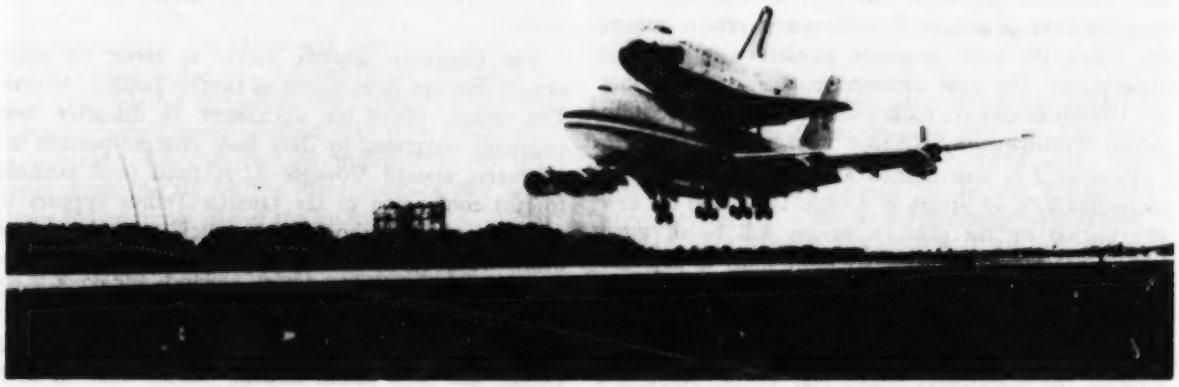
They also watched Challenger, the second orbiter, leave for the Kennedy Space Center where it is being readied for its first flight.

First STS Operational Flights

Astronaut crews for the first five Space Transportation System operational flights were announced this spring. STS-5 is scheduled for mid-November as a five-day mission to deploy two commercial communications satellites—Satellite Business System SBS-C and Telesat-E, a domestic Canadian satellite. Columbia's fifth flight will be the first to employ mission specialist astronauts. Vance D. Brand will be mission commander and Robert F. Overmeyer, pilot. Mission specialists are Dr. Joseph P. Allen and Dr. William B. Lenoir.

STS-6 will introduce the second orbiter, Challenger. Planned for January 1983, it will be a two-day mission to deploy NASA's Tracking and Data Relay Satellite, one of an eventual two-satellite system which will provide more comprehensive voice and data coverage between the ground and orbiting Space Shuttles. The crew is Paul J. Weitz, commander; Karol J. Bobko, pilot; Donald H. Peterson and Dr. Story Musgrave, mission specialists.

STS-7, a six-day flight by Challenger, is planned for April 1983. Its payloads will be a German Shuttle pallet satellite (SPAS), the second Office of Space and Terrestrial Applications instrument package (OSTA-2),



Challenger, NASA's second space-going orbiter, arriving at the Shuttle Landing Facility, Kennedy Space Center, atop a 747 carrier aircraft on July 5. Its first launch is scheduled for early 1983.

a Canadian communications satellite (Telesat F), and an Indonesian communications satellite (PALAPA-81). Robert L. Crippen will be commander and Frederick H. Hauck, pilot, of STS-7; mission specialist astronauts will be John M. Fabian and Dr. Sally K. Ride.

Richard H. Truly will be commander of STS-8 with Daniel C. Brandenstein, pilot. Scheduled for launch in July 1983, the three-day mission will be the third flight of the Challenger. Mission specialists will be Dale A. Gardner and Guion S. Bluford, Jr. The payloads will be an Indian communications satellite, INSAT 1-B, and NASA's Tracking and Data Relay Satellite (TDRS-B), the second and final element in the TDRS System.

The first flight of Spacelab, now scheduled on STS-9, the joint project between NASA and the European Space Agency (ESA), is scheduled for launch in September 1983. Mission commander for the seven-day flight is to be John W. Young and pilot will be Brewster H. Shaw, Jr. Mission specialists will be Dr. Owen K. Garriott and Dr. Robert A. Parker. Two payload specialists, one each from NASA and ESA, will be named at a later date.

Sky Log

The Moons of Uranus. Four of the five known moons of the planet Uranus have been measured for the first time. Uranus, which is nearly three billion kilometers from Earth, can be seen only with a telescope. The determination of the sizes of its moons was made from measurements of their infrared, or heat, radiation, with the NASA Infrared Telescope Facility on Mauna Kea, HI, the most sensitive instrument in the world for measuring faint infrared sources.

The new measurements reveal for the first time that these moons are large astronomical bodies, with diameters ranging up to 1,690 kms for Oberon, the largest. (The moons of Uranus are all named for characters in Shakespeare's plays—Oberon, Titania, Ariel, Umbriel, and Miranda.) Although smaller than Earth's moon, they are as large as any of the Saturnian moons, except for Titan, the only planetary satellite with a major atmosphere. The new measurements also reveal that the Uranus moons are darker than the bright icy Saturn moons investigated by NASA's Voyager spacecraft.

Voyager 2 is now headed for Uranus following its successful flyby of Saturn in August 1981, and the new information on the planet's moons will be of great importance for planning the scientific study to be made of this planet's system when the spacecraft arrives in 1986.

In addition to the measurements of the moons of Uranus, the researchers report that Triton, Neptune's largest moon, and the planet Pluto, are both too small and cold for their heat radiation to be detected. From the weakness of the sources, they calculate that Triton must be smaller than Earth's moon, and that both objects, Triton and Pluto, appear to be cold, icy objects of sublunar size. There has been speculation in the past that Pluto might be an escaped moon of Neptune.

Viking Photographs of Mars. More than 50,000 photographs of Mars taken by NASA's Viking orbiters from 1976 through 1980 have been processed at NASA's Jet Propulsion Laboratory in Pasadena, CA. The last photographs taken by the Viking 1 Orbiter were processed in late March this year. The Orbiter, one of two that arrived at Mars in 1976, was turned off in August 1980; Viking 2 Orbiter ceased operations in July 1978; and the Viking 2 Lander ceased operating in April 1980.

The surviving Viking 1 Lander, which is beginning its fourth Martian year of surface and climate studies, continues to return scientific data, including photographs, from the Mars surface. Its radio science investigations also continue.

Work at JPL includes mosaicking the orbiter images, and the study of channels, volcanoes, and tectonic features on the Martian surface. Results, reported from analysis of photos and other data, indicate (1) strong evidence that surface water exists on Mars in the form of ground ice; (2) the layers in the North polar cap appear to hold the key to understanding the climate changes on Mars as they do on Earth; and (3) the seasonal nature of Mars can be noted in cloud forms and motion, volatile migration from pole to pole, frost accumulation, and variations in temperature and pressure.

Saturnian Satellites. Data from the Voyager 2 encounter with Saturn in August 1981 have found four, possibly six, new satellites. The discoveries bring the number of known Saturnian satellites to between 21 and 23. The two "possible" objects were seen in only one observation each, so their orbits are not yet confirmed.

The innermost satellite moves at about the same orbital distance from Saturn as another satellite, Mimas. The object, about ten kilometers in diameter, was originally suggested by data from charged-particle instruments aboard Voyager 2. A third (and possibly fourth) companion of the satellite Tethys appears to move in a "horseshoe" orbit (satellites in horseshoe orbits trade orbits as they approach each other). Another satellite was found at a point about 60 degrees ahead of the satellite Dione; a fifth, about 350,000 kms from Saturn, between the orbits of Tethys and Dione, has been found circling Saturn once in 2.44 days. A faint streak in a Voyager 2 photo indicates a satellite (the "possible sixth") may exist about 470,000

kms from Saturn, between the orbits of Dione and Rhea. Its period would be 3.8 days. The satellites are about 15 to 20 kms in diameter.

Before the Voyagers flew by Saturn in 1980 and 1981 the planet was known to have ten satellites. The two spacecraft have found at least 11 to 13 more.

Lunar Sample Briefing at Goddard Space Flight Center this Fall

The Goddard Space Flight Center (GSFC) is planning a Lunar Sample Education Project Briefing in late October to acquaint educators with NASA's offer to make lunar soil and rock samples available for use in student involvement programs throughout the country. Educators in the Goddard region of Public Affairs (Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont) wishing to attend should write to: Mr. Elva Bailey, Educational Programs Officer, NASA Goddard Space Flight Center (202.3), Greenbelt, MD 20771.

To be eligible to borrow the samples, the NASA Lyndon B. Johnson Space Center (JSC) requires that all requesters receive a briefing from a NASA specialist on the use of the sample disk and materials kit. The lunar soil and rock samples are encased in a methacrylate plastic disk, 1 inch thick and 6 inches in diameter. The ½-gram samples include lunar breccia, a broken surface type; basalt, solidified volcanic material; anorthosite, an igneous rock containing calcium, aluminum, silicon, and oxygen; an orange glassy soil; a mare soil; and a highland soil. Along with the sample disk, each kit contains a lunar science film, workbook materials, slides, and an audio cassette.

The program at GSFC will begin at 9 a.m. and end at 3 p.m. It will go well beyond a specific briefing on the Lunar Sample Education Project to include presentations about the Moon and planets by some of NASA's leading authorities. Several Lunar Sample kits will be available for inspection and Goddard scientists will conduct small group sessions with these materials. The program will also include information on the security requirements for the lunar samples and suggestions for optimum use of the materials.

A certificate of participation will document attendance at the GSFC briefing, which will qualify educators to apply to JSC for loan of a Lunar Sample Education Project kit. The number of kits available is limited (about 100), so educators may have to wait several months after applying before receiving one.

1982 Science Fair Program

ISEF. At the 33rd International Science and Engineering Fair held in Houston, Texas, May 10-15, eight students received NASA awards in recognition of creative scientific endeavor in aerospace research. A team of judges from the NASA Johnson Space Center selected the students who received a Certificate of Merit and an expense-paid trip with their teachers to the Kennedy Space Center for the June 27 STS-4 launch.

The award-winning students, their schools, and their research are: **Jerry DuBois III,** East High School, Des Moines, IA, "High Speed Timing System"; **Lana Marie Hagel,** Huffman High School, Birmingham, AL, "Is Thermochemical Splitting of CO_2 and H_2O Possible in Praseodymium Compounds?"; **Kyle Harold Holland,** Stuart-Menlo High School, Stuart, IA, "Can Photons Talk?"; **Jess M. Olivieri,** Eldorado High School, Albuquerque, NM, "Electrical Space Propulsion"; **Tony Phillips,** Niceville Senior High School, Niceville, FL, "An Analysis of 21 MHz Jovian Radiation"; **Martin E. Shipley,** Los Alamos High School, Los Alamos, NM, "Solar Spectroscopy: Analyzing the Color of the Sun"; **Dagmar Taborsky,** Palmetto High School, Palmetto, FL, "Waste Water Bioclarification"; **Shari-Lynn Umlas,** North Miami Beach High School, North Miami Beach, FL, "Effects of Stress on Polymorphonuclear Leukocyte Chemotaxis in *Macaca fascicularis.*"

In addition, ten students were awarded Honorable Mention: **Neal H. Atebara,** Waiakea High School, Hilo, HI; **Christi Kay Barton,** Christoval High School, Christoval, TX; **Richard A. Bratcher,** Duncan High School, Duncan, OK; **Marie Christian,** Dixie High School, St. George, UT; **George Coia,** Fr. James B. Hay School, Alamogordo, NM; **Andrew Miles Cudmore,** Bryanston School, Blandford, England; **Michael I. Hyman,** Centennial High School, Ellicott City, MD; **Tracy L. Peters,** Ygnacio Valley High School, Concord, CA; **Bryan A. Shirley,** Franklin County High School, Winchester, TN; **Edward W. Williams, Jr.,** Smith High School, Atlanta, GA.

Tracy L. Peters. With his 1982 Honorable Mention recognition, Tracy Peters became the first four-time NASA award-winner at the ISEF. In 1979, at the 30th ISEF he won an award-trip to the Jet Propulsion Laboratory for the Voyager 2 Encounter with Jupiter. He was a student at East Junior High School, Casper, Wyoming. In 1980 and 1981, as sophomore and junior at Kelly Walsh High School in Casper, Tracy's exhibits at the 31st and 32nd International Fairs were also cited for excellence and he received an Honorable Mention award at each.

State and regional fairs. The directors of 211 state and regional fairs requested NASA's participation in their programs this year. At each fair up to five winners could be cited for outstanding achievement in aerospace research. In addition, several NASA Centers provided special programs.

This was the 15th year for the **Goddard Space Flight Center's** annual honor day for their winners. On July 2, the Center welcomed the NASA science fair winners from nearby states and the District of Columbia. Besides touring the facilities, they heard special presentations on the Center's programs, the Shuttle Transportation System, and the Voyagers that travelled to Jupiter and Saturn. Their visit, as each of the 14 before them, concluded with a presentation of a memento of their Goddard visit.

The **Johnson Space Center** invited its science fair winners to the Center on May 20. Some 25 students, teachers, and parents enjoyed a day at the Center highlighted by a discussion of the Space Telescope by Dr. Karl G. Henize, astronaut-astronomer.

On May 25, the **Langley Research Center** honored its science fair winners with a program that included an informal discussion with the chief scientist on what it means to be a scientist or engineer and a tour of selected laboratories to meet other professionals. A special recognition was a car pass to the STS-4 launch.

The **Marshall Space Flight Center** conducted its fourth Science Fair Award Winners' Conference on June 25. Eight young winners, representing schools in six states, with members of their families and teachers were recognized by MSFC for their outstanding aerospace-related projects. Their exhibits, some of which were judged by Marshall Center personnel, appeared in fairs in Alabama, Arkansas, Missouri, Tennessee, and Louisiana. The Director of MSFC's Science and Engineering Directorate, welcomed the students to their day at the Center during which they heard a presentation on the STS-4 mission and toured several of the facilities.

1982 science fair award-winners honored by the Goddard Space Flight Center at the Center's 15th annual program of this recognition.

Finalists Chosen in Second Shuttle Student Project

Twenty finalists selected in the second national Shuttle Student Involvement Project, a joint venture of NASA and the National Science Teachers Association (NSTA), attended a special Space Shuttle conference in August at NASA's Kennedy Space Center with their teacher-advisors. The group received briefings on Shuttle integration procedures, toured the Center, and viewed launch preparations for Columbia's next flight scheduled for November.

The student-winners, their schools, and teachers (T) are: **Sara H. Abozeid,** James Madison Memorial High School, Madison, WI, **Douglas Johnson** (T); **William S. Akmentins,** Appleton High School West, Appleton, WI, **David McKay** (T); **Sean M. Amberg,** Seward High School, Seward, NE, **Donald Sackett** (T); **Lloyd Bruce,** Sumner High School, St. Louis, MO, **Vaughan Merrill** (T); **S. Richard Cavoli,** Marlboro Central High School, Marlboro, NY, **Annette M. Saturnelli** (T); **Steven D. Chang,** Tustin High School, Tustin, CA, **Ronald Bruce** (T); **Todd J. Egan,** Bellarmine College Preparatory, San Jose, CA, **Sandra Capano** (T); **Andrew I. Fras,** Binghamton Central High School, Binghamton, NY, **Howard Fisher** (T); **Jeff B. Fuchs,** Adlai E. Stevenson High School, Livonia, MI, **Donald O. Bundy** (T); **Edward W. Gulley,** R. J. Reynolds High School, Winston-Salem, NC, **Barbara Stelter** (T); **Douglas D. Hensley,** Park Hill High School, Kansas City, MO, **Richard Kavanaugh** (T); **William D. Loftis, Jr.,** Winfield High School, Winfield, WV, **Alleta Machmer** (T); **Timothy D. Maclay,** Springfield High School, Springfield, PA, **Joseph Zumpano,** (T); **Shawn P. Murphy,** Newbury High School, Newbury, OH, **Rexford Roberts** (T); **Tracy L. Peters,** Ygnacio Valley High School, Concord, CA, **James R. Cobb** (T); **Gregory S. Peterson,** Box Elder High School, Brigham City, UT, **Darrell Turner** (T); **Dan M. Poskevich,** Waverly Central High School, Waverly, TN, **Andrew S. Hendrix** (T); **Scott M. Tyner,** Arlington High School, Pleasant Valley, NY, **Jan. L. Stoutenburgh** (T); **Chia-Lien Wang,** Richfield High School, Waco, TX, **John Wilson** (T); **Timothy R. Young,** West Senior High School, Madison, WI, **Gary Graper** (T).

A third Shuttle Student Involvement Project opened in September. Regional conferences will be held in March 1983 and student winners selected in May. Information on entry procedures can be obtained by writing to the NSTA at 1742 Connecticut Avenue, NW., Washington, DC 20008.

Recent NASA Publications

The following publications are available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Voyages to Saturn, SP-451, is the story of the Voyager spacecraft encounters with the ringed planet. It includes a brief discussion of the planet, the Pioneer spacecraft mission that preceded the Voyagers, the Voyager mission that flew by Jupiter en route to Saturn, and concludes with "The New Saturnian System." There are suggested technical and nontechnical additional reading lists and a glossary. Paperbound, illustrated, 227pp. $9.50.

Sun, Earth, and Man, EP-172, presents an overview of our knowledge of Earth's star from "Before Sputnik" to "The Future." Sources and further reading lists are included for each chapter. Color, 75pp. $5.50. (No. 1982—372-201).

Spinoff 82 is the latest edition of the annual produced by NASA's Technology Utilization and Industrial Affairs Division; it is an up-to-date summary of NASA's major aeronautical and space programs, their contributions to American technological growth, and the ways in which they are producing benefits to Earth's people. Paperbound, illustrated, 232pp. $7.50.

Food for Space Flight, NF-133, is an eight-page NASA Facts pamphlet describing the food used by astronauts from Project Mercury to the Shuttle. It includes a Space Shuttle Food and Beverage List and a Typical Menu for the First Four Shuttle Flights. Color. $2.25.

General Aviation, NF-135, is an eight-page NASA Facts pamphlet discussing the broad goals of NASA's general aviation programs: continuing improvements in efficiency, safety, environmental compatibility, and utility. B/w. $2.00. (No. 1982—542-389).

Mailing List Purge

By government regulation, we may retain names on our mailing list for a limited time only unless the addressees indicate a wish to receive further mailings. We also are limited to a list of 55,000 names, which has grown beyond that total.

NASA's Education Services Branch is now conducting a mailing list purge to comply with these regulations and to eliminate the current labels that are being returned marked "Addressee Unknown." To maintain your name on the list, fill out and return to NASA the special card that has been mailed to you.

Where to Write for Services

NASA publications should be ordered from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Publication lists, film lists, and information about other services are available from the Educational Office at the NASA center serving your state. See the list below. There are special resource centers for educators at the Kennedy Space Center, Lewis Research Center, and Alabama Space and Rocket Center, Huntsville, AL.

NASA Ames Research Center
Moffet Field, California 94035
Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

NASA Lyndon B. Johnson Space Center
Houston, Texas 77058
Colorado, Kansas, Nebraska, New Mexico, N. Dakota, Oklahoma, S. Dakota, Texas

NASA John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
Florida, Georgia, Puerto Rico, Virgin Islands

NASA Langley Research Center
Hampton, Virginia 23665
Kentucky, N. Carolina, S. Carolina, Virginia, West Virginia

NASA Lewis Research Center
21000 Brookpark Road, Cleveland, Ohio 44135
Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

NASA George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, Tennessee

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The Administrator of the National Aeronautics and Space Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through December 31, 1981.

NASA REPORT TO EDUCATORS is published four times per year for the community of educators. Recommendations are solicited from readers, and should be addressed to the Education Services Branch, Academic Affairs Division (LCG-9), National Aeronautics and Space Administration, Washington, DC 20546. Photocopying for school use is approved.

Muriel M. Thorne, Editor

NASA Report to Educators
Vol. 10, No. 2 Summer 1982

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Volume 10, No. 3 Fall 1982

Report to Educators

A New Look

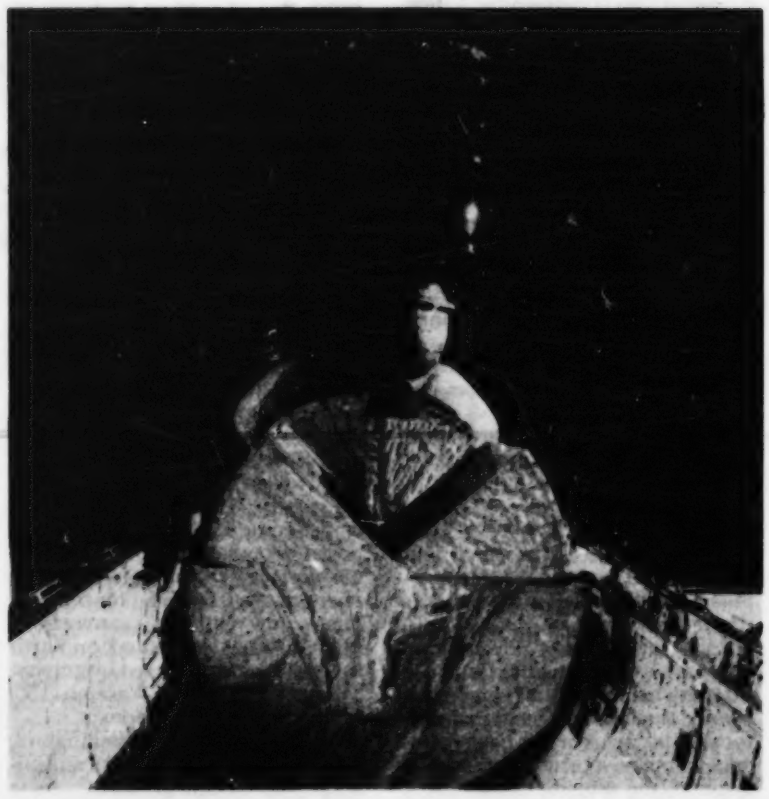
To begin this academic year we planned a new look. Unfortunately, unforeseen circumstances—budget trials and publications problems—have delayed the 1982 Fall and Winter issues. We can but apologize for the tardiness, hope these two issues are worth waiting for, and try to begin the new calendar year on schedule.

Only the design has changed. The *Report*, since the first issue, has provided the educational community with material about NASA projects and activities and its educational programs and services. We hope the new look highlights the information with an easy-to-find-and-read format.

From the outset the editors have collected information that would be not only interesting to teachers, but also of some application to their classrooms. We have included summaries of major NASA programs, their results, pertinent photographs. Are these useful and understandable, or do they mostly repeat information that you have already obtained from other news sources?

When information is available, we try to let you know about NASA-sponsored or supported aerospace activities of state, area, and community groups. Would student contributions be of interest? What has your classroom done lately?

One obvious difficulty with a newsletter of this kind is that it goes to persons in a large variety of disciplines at a wide range of grade levels. To find something for everyone, we need—and will appreciate—your help. Send any comments and suggestions to: Editor, *NASA Report to Educators*, Education Services Branch (LFC-9), National Aeronautics and Space Administration, Washington, DC 20546.



Milestone moment—the SBS-3 satellite springs into space from its cradle in the Columbia's *cargo bay.*

"In Business"

When the Satellite Business System's SBS-3 communications satellite was deployed into Earth orbit from the Space Shuttle **Columbia** ***on November 11, 1982, the United States began a new chapter in space age history. Twenty-four hours later, a second communications satellite, Telesat Canada's Anik C-3, was launched from*** **Columbia's** ***cargo bay. The Space Transportation System (STS) was operational, its fifth flight a commercial success.***

NAS1.49:

"In Business"

The Flight
A perfect launch followed a flawless countdown on November 11. At 7:19 a.m. EST the STS-5 flight began at the Kennedy Space Center. For the first time *Columbia* carried a crew of four: Commander Vance D. Brand, Pilot Robert V. Overmyer, and Dr. William B Lenoir and Dr. Joseph P. Allen, mission specialists.

In addition to being the first commercial flight and the first spacecraft to have a crew of four, STS-5 was the first mission to use the Shuttle's Payload Assist Module and a new ejection system.

The Cargo
The deployment of the two satellites was the mission's primary objective.

SBS-3 is the third in a series of Satellite Business System's communications satellites; Anik C-3 is the fifth of a series of satellites that provides domestic communications services for Canada. Identical in size and shape, they were built to handle as many as 10,000 trancontinental phone calls at once and together will serve the tv and telephone needs of North America for the next decade.

Each satellite was powered up by computer command from *Columbia's* cabin: the first commands opened the thermal shield that protected the spacecraft; next, commands rotated a turntable that gave a spin to the satellite to stabilize it and its attached Payload Assist Module (PAM); final commands fired explosive bolts to free a powerful spring that pushed the satellite away from *Columbia*.

Columbia was maneuvered away to protect it from the PAM's rocket engine exhaust. The owners took over control of the satellites and each control center on Earth fired the PAM to put its satellite in a transfer orbit and later maneuvered it into a geosynchronous orbit at 35,680 kilometers over Earth's equator where the satellite stays above one point on Earth. SBS-3 is over the Atlantic Ocean and Anik C-3 over the Pacific.

Getaway Special. Another cargo item was the second Getaway Special payload, a part of the material science program of the German Ministry of Research and Technology. The experiment periodically X-rayed a molten mixture of mercury and gallium to record their appearance on film under microgravity conditions.

SSIP. Three students had experiments aboard the *Columbia*, part of the Shuttle Student Involvement Project (SSIP) co-sponsored by NASA and the National Science Teachers Association; corporate sponsors fund experiment development.

Aaron K. Gillette, a freshman at Western Carolina University in Cullowhee, NC, was a junior at Winter Haven Senior High School (FL) when he proposed his experiment to examine the effects of near weightlessness on the formation of sponges. His corporate sponsor is Martin Marietta Aerospace, Orlando Division, where a similar experiment was performed to provide ground control data.

D. Scott Thomas of Johnstown, PA, is a freshman at Utah State University. When a junior at Richland Senior High School, he proposed his experiment to study liquid surface tension convection in microgravity. Surface tension induces flow patterns (convection) in liquids that are heated; on Earth the patterns are affected by gravity. Thiokol Corporation, Wasatch (UT) Division, is Thomas' sponsor.

Michelle A. Issel of Wallingford, CT, is a freshman at American University in Washington, DC. As a junior at Mark T. Sheehan High School, she proposed an experiment to grow a geometrically perfect crystal in microgravity. Her corporate sponsor is Hamilton Standard, Windsor Locks, CT.

The Spacesuits
The mission plan called for the mission specialists to perform the first extravehicular (EVA) activity on a Shuttle flight. For approximately three hours they were to test their suits' cooling and communications systems and practice procedures for an actual contingency space walk in *Columbia's* cargo bay.

To the astronauts' great disappointment, both spacesuits failed, which forced cancellation of the EVA.

Postflight inspection by technicians at the Johnson Space Center showed that the device that was supposed to regulate the oxygen pressure inside of Lenoir's spacesuit was missing two tiny plastic inserts, and one of two small magnetic sensors that run a fan feeding oxygen into Allen's suit apparently failed just after he put it on.

To reschedule the EVA, the three-day STS-6 mission is being extended to five days.

Touchdown
Five days and two hours after launch (9:33 a.m. EST, November 16), the *Columbia* touched down safely for the fifth time. The STS was operational—its reusable spacecraft, cargo delivery, several-member crews, heralded routine spaceflight.

Educators' Conferences
Some 165 educators, including 25 science fair directors, met during November 9-11 at the Kennedy Space Center and Rollins College. The program included a tour of KSC; a presentation by astronaut Jon McBride; discussions of the STS Operations at KSC; the SSIP; the International Science and Engineering Fair; the Aerospace Laser Disc Project; and STS-5 launch.

A second program was held at the Johnson Space Center in Houston on November 12 where a full day's schedule for 200+ participants included a lecture on the STS mission by astronaut George Nelson and a discussion of Student Experiment Integration with visits to Mission Operations Control Room, the Shuttle Mock-up, and Skylab Trainers and Simulators.

Space Shuttle Landing #5 Educators' Conference was held November 15-16 at the California Museum of Science and Industry, sponsored by the museum and NASA's Ames Research Center, Dryden Flight Research Facility-ARC, and Jet Propulsion Laboratory. The 200 participants, who enjoyed a varied program of lectures, a multimedia presentation on Jupiter and Saturn, and guided tours of the museum, were joined by 300 more educators at *Columbia's* landing.

OSTA-1 Results

The STS-2 mission in November 1981 carried the Office of Space and Terrestrial Applications' first payload (OSTA-1). A set of scientific experiments, OSTA-1 demonstrated the Shuttle's operational capability as a platform for Earth-related research.

It proved the potential of routine access to low Earth orbit. Because it has never been possible to refurbish experimental sensors placed in orbit, the Shuttle's ability to carry instruments into space and return them to Earth adds a new dimension to remote-sensing techniques.

Although the STS-2 flight was shortened, early OSTA-1 results were heartening. The final results are rewarding indeed—those of three experiments, announced in November, have brought new excitement to geologic mapping and remote-sensing.

SIR-A

Analysis of results from the Shuttle Imaging Radar (SIR-A) experiment shows significant results in the field of geologic mapping in the southeastern Egyptian desert, the salt desert of the Great Kavir area of Iran, the Kelpin Tagh uplift in northwestern China, in the densely forested southeastern Kentucky Appalachian Plateau, in the mountainous regions of western Guyana, and in the eastern Sahara.

After the flight, the SIR-A was recognized as a complete success. Eight hours of excellent data provided photographic-like images of geological terrain. Radar imagery records differences in surface roughness and terrain attitude and can be used to delineate geological features. Because it penetrated clouds, darkness, and vegetation, SIR-A provided a new perspective on the geology of tropical areas.

Mapping has begun on linear features visible in the radar maps of the southeastern Egyptian desert and has led to approximate interpretation of some of the local geologic features revealed. The area immediately west of the Red Sea has numerous features aligned in such a way as to suggest a possible link between the lineaments and the Red Sea Rift. These features may be hundreds of millions of years older than the Rift and could have been reactivated by it. Many of the characteristic rock types from the different geologic periods show up easily in the radar scenes and will make the geologic analysis of remote stretches of Egypt easier.

In the salt desert of the Great Kavir region of Iran, the Shuttle radar was able to complement Landsat imagery and help differentiate the composition of the surface layer; it also helped identify whether it was altered by erosion or by fracturing of the surface salt crust. In some areas strata of the folded Miocene era bedrock were visible through the surface, a feature usually obscured from view in ground survey work.

In the southeast Kentucky Appalachian Plateau region, SIR-A showed already-mapped lineaments 15-kilometers or longer. It added to the detail by showing much shorter lineaments oriented nearly parallel to the fault trends of that area; field work supports the observation that the Shuttle radar discovered new linear features associated with Appalachian region faulting.

In the Pakaraima mountains of western Guyana the SIR, despite the complete rain forest cover, uncovered significant structural detail; lineaments and other major surface features were clearly visible in the images. Linear stream valleys and drainage patterns of the region appear to be controlled structurally because the drainage channels follow junctures of previously mapped fault lines. Before these features can be conclusively interpreted, further verification is needed from field surveys; this area of Guyana and the adjacent region of Venezuela are particularly inaccessible and very little ground survey work has been done.

Some of the most exciting results have come from the eastern Sahara Desert region, where the SIR-A penetrated the extremely dry Selima Sand Sheet and Arbain Desert (in Chad, southern Egypt, and northern Sudan) to reveal previously unknown buried valleys, geologic structures, and possible Stone Age occupation sites.

The radar signal, penetrating the sand dunes, drift sand, and alluvium-filled valleys of the Arbain Desert, has revealed bedrock and gravel subsurface features, some of which are nearly as broad as the Nile River Valley and could perhaps be as old as the Early Tertiary period (up to 50 million years ago.)

The now-vanished major river systems that carved the large prehistoric valleys probably accomplished most of the erosional stripping in this flat and hyperarid region. There is even evidence of intermittent running water during the Quaternary pluvial period (the last million years.)

The presence of old drainage networks, originally detected in the radar images and confirmed with special post-flight ground geoarchaeological studies, suggest an explanation for the location of many playas and present-day oases in the region. These same oasis areas have been the center of episodic human habitation, and in fact may have influenced habitation patterns within historic time.

The average depth of the radar signal and penetration, based on laboratory and field studies, varies locally from 1 to 5 meters. The penetration of dry sand by imaging radar can now provide a new tool for geoarchaeology and for the search for ground water and other resources in arid and hyperarid regions.

The Arbain Desert region of southwestern Egypt and northern Sudan, is known to have supported human habitation during several periods from about 200,000 to 40,000 years ago and again as recently as 10,000 years ago. These Quaternary period occupations are believed to be coincident with the pluvial conditions that periodically changed the desert region to a savanna-like environment allowing small streams and playa lakes to exist. By about 5,000 years

ago hyperaridity again set in and the region was abandoned by humans.

The sand sheet is virtually featureless, consisting of hundreds of kilometers of flat terrain composed of course sand and fine pebbles. The windblown sand cover overlies alluvial soils dated to about 8,500 years ago. The radar pictures show a completely different type of terrain underlying the sand sheet. The subsurface contains numerous river valleys and associated tributaries which were known previously only to Neolithic and Paleolithic people and possibly early human ancestors who inhabited the area during its wet periods.

The results of the SIR experiment will be useful in interpreting the history of the various drainage basins that have developed, dried up, and evolved in this region of the Middle East. At least four river systems predate the present Nile River. Much of the earlier drainage patterns has been lost because of geologic evolution or weathering, but the indications from the SIR images point positively towards being able to reconstruct at least some of the prehistoric drainage systems.

As an example, some of the river drainage patterns discerned in the radar images flow opposite to the present day Nile system. These prehistoric systems could date as far back as the Tertiary Period (up to 65 million years ago). This paleology will be further assisted by future Shuttle radar flights.

SMIRR

The first orbital detection of clay and carbonite-bearing minerals has been confirmed by the Shuttle Multispectral Infrared Radiometer (SMIRR) experiment. For the first time, minerals other than limonite (a common suite of iron-bearing minerals) have been identified remotely by an orbiting spacecraft sensor. This identification was done on the basis of spectral reflectances in the infrared portion of the electromagnetic spectrum and is an important step forward in the use of remote sensing techniques for geological mapping.

The instrument was able to identify direct limestone (a carbonite-bearing rock), kaolinite (a hydrous, aluminum silicate clay mineral), and possibly montmorillonite (another hydrous silicate of aluminum) from orbit.

Different types of clay minerals are commonly associated with different types of mineral deposits. The presence of specific clays is commonly used as an ore guide in mineral exploration and development. The SMIRR results indicate that it is possible to distinguish different types of clay minerals from space, and potentially possible to map the abundance of these minerals in arid environments. These results point to the tremendous potential of future narrow-band imaging systems for mineralogical mapping and geological exploration. Perhaps the most significant aspect of this recent work is that previously this clay-mineral identification was possible only using laboratory sampling techniques.

The SMIRR used an area between Kharga and Aswan, Egypt, as a test site for the orbital mineralogical studies. The test site contained known deposits of minerals and was used as a ground truth segment for the experiment analysis. The study area was sparsely vegetated and of mixed geology. The instrument consists of ten channels which range in wavelength from the visible red through the shortwave infrared, with the infrared bands being very narrow in bandwidth. In fact, the spectral resolution of this sensor was superior to all previous multispectral sensors used in space.

Previous studies aboard Skylab, the Landsat spacecraft, and aircraft have defined the shortwave infrared region as being the most selective in identifying mineral types with remote-sensing techniques. The analysis used for the identification is quite similar to the "signature" analysis used for vegetation studies with Landsat sensors. This analysis keys on the different reflectance of different materials in the various wavelengths of the visible and infrared spectrum.

The difference between montmorillonite and kaolinite, for instance, lies chiefly in the extreme slope of the reflectance curve for kaolinite in the wavelength region from 2.1 to 2.2 microns. It is this extremely narrow spectral resolution which enabled the SMIRR to distinguish different types of clay minerals. Skylab, Landsat, and most of the aircraft sensors have broad spectral bandwidths that are not able to detect the subtle reflectance differences which differentiate clays from each other.

MAPS

A new technique for mapping gases in the Earth's atmosphere proved accurate when compared to ground-initiated studies. The Measurement of Air Pollution from Satellites (MAPS) experiment charted concentrations of gases around the world over a range from 38°S to 38°N latitudes.

The experiment used a gas filter radiometer to produce measurements of the carbon monoxide mixing ratio in the middle, upper, and lower troposphere.

The radiometer method is simpler and much less expensive than previous gas chromatograph devices. The primary objective was to verify the use of this cheaper techinque as an orbital pollution monitor.

The experiment produced concentration maps of carbon monoxide from data collected during an orbital pass of the Shuttle that began over central America, continued east over the Mediterranean Sea, turned southeast over the Persian Gulf and Arabian Sea, and extended to the southern tip of India. The concentration of carbon monoxide within this extended area ranges from 70 parts per billion over the Americas to a high of 115 parts per billion over the eastern Atlantic Ocean and 140 parts per billion in the Mediterranean area.

The analysis of the experiment data so far indicates significant concentrations of middle troposphere carbon monoxide mixing with both north/south and east/west variation over the north Atlantic, the Mediterranean Sea, and the Middle East. Accuracy of the measurements has been determined to be within 15 percent with a repeatability of about five percent from orbit to orbit. The experiment was on for about 42 hours, and the investigators were able to corroborate the sampled areas with instrument readings taken with underflying aircraft and with other surface truth information.

NASA plans to refly this experiment on the 17th Shuttle, scheduled for the summer of 1985, to study seasonal variations in the total abundance and regional distribution of carbon monoxide within the Earth's atmosphere.

Results of the OSTA-1 experiments were published in *Science*, Vol. 218, 3 December 1982, pp. 993-1033.

Sky Log

IRAS
Late January is the target date for the launch of the Infrared Astronomy Satellite (IRAS). To be launched into a near-polar orbit atop a Delta rocket at the Western Space and Missile Center in California, the first infrared survey satellite is an international project with a telescope supplied by NASA, a spacecraft built by the Netherlands Aerospace Research Council, and tracking services supplied by the United Kingdom. All three nations are participating in the scientific instrumentation and observing program of the IRAS mission, which is expected to complete two sky surveys during its operational life.

Voyager
By October 1982 Voyager 2 had travelled about 1/10th of the distance it must cover for its encounter with the planet Uranus in January 1986.

Since its launch in August 1978, the spacecraft has travelled some three billion kilometers through space. Its condition is good: most of the science instruments are functioning well; 67 of the original 104 kilograms of propellant remain to be used for attitude control and trajectory correction; and the two radioisotope thermoelectric generators are furnishing 422 watts of electrical power, 92 more than required. One scan platform actuator is showing signs of wear and the radio receiver has reduced tracking capability, but neither problem is expected to affect the encounter with Uranus.

In accomplishing its primary mission objectives, Voyager 2 obtained about 32,000 images of Jupiter and Saturn, their rings, and 13 of their satellites. Planning is now underway for imaging Uranus with its rings and five satellites.

Mission controllers at NASA's Jet Propulsion Laboratory in Pasadena, CA, are in daily communication with the spacecraft. One-way radio time from Voyager 2 to Earth is now 90 minutes.

Travelling with a heliocentric velocity of 19.9 km/second (sufficient to ultimately escape the solar system), Voyager 2 has the distinction of being the second fastest object made by humans. Voyager 1 is travelling slightly faster.

ISEE-3
On June 10, 1982, flight controllers at the Goddard Space Flight Center (GSFC) began moving the four-year-old International Sun-Earth Explorer (ISEE-3), on a series of looping trajectories. The first satellite to orbit a libration point (a point of balance between Earth's and Sun's gravitational pulls), in its new position ISEE-3 will be the first to conduct an exploratory survey of Earth's magnetotail and first to fly through a comet's tail. It will study the magnetotail through 1983, fly across the wake of comet Giacobini-Zinner in September 1985, and study the solar wind's effect on Halley's Comet during late 1985 and early 1986.

ISEE-3 has already outlived its designed lifetime of three years; it remains in good condition and carries ample fuel supplies.

The spacecraft has been monitoring the solar wind of charged particles and energy streaming from the Sun toward the Earth. GSFC now will use ISEE-3's magnetometers and charged-particle monitors to chart Earth's magnetotail (produced by the flow of solar wind past Earth) and compare it with the tail of a comet.

Its new program offers an opportunity to expand cometary studies scheduled for the appearance of Halley's Comet. Intercepting the small comet Giacobini-Zinner will permit not only comparative studies between it and Halley's Comet, but also an opportunity to fly through a cometary tail, which the Halley's probes will not attempt.

To send ISEE-3 on a trip to three different targets over almost four years and billions of kilometers, flight engineers must extend its fuel range by a series of gravity assists from the Moon. But the toughest challenge will be flying through a comet's tail. Little is known about a comet's environment and, in the case of Giacobini-Zinner, even the comet's orbital path remains to be determined.

Comet Halley Watch
At a meeting of the International Astronomical Union last summer, the formation of the International Halley Watch (IHW) was announced. The IHW is an international network of scientists who will observe Halley's Comet as part of a coordinated program when the comet passes Earth in 1986. The IHW will invite all Comet Halley observers, professional or amateur, to share their data with the IHW networks now being created. Ground-based observations and those of balloon, airborne, and Earth-orbital instruments will be collected by the IHW. The data compiled will form the Halley Archive, largest collection of information produced on a single comet.

Quasar PKS 2000-330
An international team of astronomers has discovered the most distant object in the universe. The astronomers, from the United States, Great Britain, and Australia, working through the Jet Propulsion Laboratory (JPL) determined that a quasar designated PKS 2000-330 is more than 12 billion light years away. Light arriving at Earth today from PKS 2000-330 began its journey here before the solar system, and probably the Milky Way galaxy were formed. (The solar system is believed to be about 4.6 billion years old, the Milky Way, about 10 billion.)

The search that resulted in discovery of PKS 2000-330 began ten years ago using antennas of JPL's Deep Space Network (DSN). JPL astronomers suggested that the DSN antennas could determine accurate positions of radio sources in the sky that might be quasars. Joined by astronomers from Australia and Scotland, the team measured a large number of radio sources discovered with the 64-meter Parkes radio telescope in Australia and matched the radio sources with objects in photographs. Then the spectrum of PKS 2000-330 was measured to reveal a red shift of 3.78, greater than any red shift ever measured. (The red shift—a measure of how much a distant object shifts its light toward the red end of the spectrum—is believed to indicate the object's relative velocity away from Earth, and therefore, its distance.)

Quasars today present one of astronomy's greatest puzzles. They appear to be the most distant objects in the universe. They also appear to be expending vast amounts of energy—much more energy than theory can account for.

Seasat Results

Images recently produced from data collected by the Seasat oceanographic satellite flown by NASA in 1978 show major geologic features on the ocean floor. The images, made by measuring the topography of the ocean surface with the satellite's altimeter, create a global image comprised of more than 50 million physical measurements, including ten corrections for atmospheric and other interferences. The measurements were produced by the same data, but each was processed differently to emphasize a unique set of features.

The images supply new, detailed bathymetric (water depth) and geologic information for wide areas of the world's seas, especially in the southern oceans. Existing bathymetric charts show the Louisville Ridge as a discontinous chain of mountains running southeast of the Tonga-Kermadic Trench. The Seasat image of this region clearly shows a nearly continuous chain of features.

Seasat collected 70 days of oceanographic data over a 100-day period. The radar altimeter measured the distance from the spacecraft to the ocean surface. By calculating the satellite's position, and correcting for passage of the radar beam through the atmosphere, the height of the ocean surface relative to a reference ellipsoid was determined.

The resulting maps, which show the ocean surface at one-half degree resolution, were created through computer processing of the Seasat altimeter data. They are designed to emphasize features on the ocean floor ranging in size from 50 to 500 kilometers.

Mapping the sea floor by measuring the sea surface topography is possible because of the relationship between gravity, the sea floor, and the ocean. Gravity over the Earth is not constant; it varies depending on the local thickness, density, age, and geology of the crust. The ocean conforms to variations in this uneven gravity field because it is a fluid. Sea surface topography dominantly conforms to the sea floor topography. A mountainous formation on the sea floor, for example, causes a peak on the ocean surface detectable by a satellite altimeter.

International Young People's Aviation & Space Art Competition

The World Aerospace Education Organization (WAEO) which promotes, through international cooperation, the aerospace education of youth, is sponsoring an art competition for anyone who is 9 to 17 years of age on July 1, 1983. Judging will be in three age categories: I (9, 10, and 11); II (12, 13, and 14); and III (15, 16, and 17).

The theme, Aviation and Space Flight Serving Humanity, may be expressed in any medium, but all artwork must be matted with the overall size not exceeding 43.2 x 58.4 cm (17 x 23 in.)

The artist's name, age, address, and sponsor (if appropriate) should be clearly written on the back of the work. Entries, mailed at the expense of the competitor, should be sent to: Education Services Division (P-700), National Air and Space Museum, 6th Street and Independence Avenue, SW, Washington, DC 20560. Deadline: May 30, 1983.

Prominent aviation and space artists will judge the entries. An alabaster airplane will be awarded to the first place winners. Special certificates and ribbons will awarded to the first through third place winners in each category. A selection of the entries will be exhibited in Washington, D.C. from July 10 through August 19, 1983. Those selected for exhibit will be acknowledged by a special WAEO certificate.

All entries become the property of the WAEO Congress and will not be returned.

Education News

From NASA Headquarters

In the summer of 1982 a reorganization of the Office of External Relations at NASA Headquarters placed the Education Services Branch and publications production section in the Public Affairs Division. **Dr. Curtis M. Graves** was named the Division's Deputy Director for Academic Affairs. **William D. Nixon** is Chief of NASA's Education Services.

The realignment changed neither programs nor services—those provided to elementary and secondary schools, the research and lecture programs offered to colleges and universities, those designed for adults and those for urban communities, and educational resource materials—all remain part of a comprehensive, across-the-board program to serve the educational community at all levels.

An important part of our program is an awareness of the state of education in the nation. As most of you know, recently, several of the media have noted the serious state of mathematics and science education in the U.S. Research shows that 50 percent of the nation's 1982 high school graduates had only one year of science, and 25 percent, only a year of math, during their high school years. Most of them had no math or science past the sophomore year. In several states, if a student has taken 8th-grade science, he or she does not have to take it in high school.

Research also shows that less than one percent of the baccalaureate degrees awarded in 1982 were given to teachers prepared to teach math or science at the secondary level. Many universities have closed these departments so that courses in secondary science teaching are not even offered.

The nation will pay a tremendous price for this slippage in the quantity and quality of science and math teaching in our country. President Reagan is quoted in a *U.S. News and World Report* (Oct. 18, 1982) article as saying, "The problems today in elementary and secondary-school science and mathematics education are serious—serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces." The contrast of our science and math education with that of Western Europe, Russia, and Japan explains the President's statement. A high school graduate in these countries has had a mandatory eight years of science and six of mathematics, including two years of physics and one of calculus. Each graduate is also fluent in a language other than the native tongue.

Another part of the education problem is the current nearly-11-percent-unemployment rate and data showing that by 1990 there will be a 40 percent increase in jobs requiring science, math, and technology. High tech and the teaching of subjects that lead to high technology fields are the wave of the future, which guidance counselors as well as science and math teachers must recognize.

Educators must help turn the science and math teaching problem around. Some suggestions we have heard include increased minimum standards, intensive inservice training for unqualified teachers, mandatory summer teacher workshops, and space and science camps for both teachers and students.

At present, NASA's Education Services offices (see p. 8) provide assistance that augments many of these ideas. We are interested in your suggestions on how our programs—within budget and staffing limitations—can do more to alleviate the current crisis in science and math teaching.

Curtis M. Graves

From the Langley Research Center

Harold E. Mehrens

The NASA staff and professional colleagues in the educational community were saddened by the death of **Harold E. Mehrens** in November.

As Head of the Office of Educational Services in the Office of External Affairs at the Langley Research Center (LaRC), Mr. Mehrens was responsible for NASA's educational services to Kentucky, North and South Carolina, Virginia, and West Virginia. He was involved with the President's 1980 Study Committee on Education, where he helped develop new teaching techniques for academically talented students; at the Center he established the Governor's School for the Gifted and the NASA Summer High School Apprenticeship Research Program. He also will be remembered as a major contributor to NASA's development of curriculum materials for industrial arts educators.

Mr. Mehrens joined NASA in 1965 as Head of the Educational Programs Branch at the Kennedy Space Center, continuing a career that began with his selection as a NASA Spacemobile lecturer in 1963. He had been LaRC's educational officer since 1972.

A native of New Mexico, Mr. Mehrens received a B.S. degree from Eastern New Mexico University. He earned an M.S. degree from the University of Maryland.

Publications

The following publications are available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Aerospace Bibliography, Seventh Edition, EP-48, is the first update of this compilation of aerospace resources since the Sixth Edition of 1972. The book is arranged in three parts: a Subject Index, Annotated Bibliography, and Reference Books. There are an Index to Titles and a list of Publishers' Addresses as well. Paperbound, 140 pp., $6.00. (Stock No. 033-000-00866-0.

Ten Years of Planetary Exploration, WAL-109, is a large wallsheet highlighting NASA spacecraft planetary research from 1972 through 1981. During that time all the planets out to Saturn were investigated and photographed; the wallsheet indicates the several spacecraft trajectories and reproduces photographs of the planets with text describing major discoveries. Color. $4.50. (Stock No. 033-000-00861-9).

* U.S. GOVERNMENT PRINTING OFFICE: 1983-381-566:101

Where to Write for Services

Publication lists, film lists, and information about other services are available from the Education Services office at the NASA center serving your state. See the list below. There are special resource centers for educators at the Kennedy Space Center, Lewis Research Center, and Alabama Space and Rocket Center, Huntsville, AL.

NASA Ames Research Center
Moffet Field, California 94035
Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

NASA Lyndon B. Johnson Space Center
Houston, Texas 77058
Colorado, Kansas, Nebraska, New Mexico, N. Dakota, Oklahoma, S. Dakota, Texas

NASA John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
Florida, Georgia, Puerto Rico, Virgin Islands

NASA Langley Research Center
Hampton, Virginia 23665
Kentucky, N. Carolina, S. Carolina, Virginia, West Virginia

NASA Lewis Research Center
21000 Brookpark Road, Cleveland, Ohio 44135
Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

NASA George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, Tennessee

The Administrator of the National Aeronautics and Space Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through December 31, 1984.

NASA Report to Educators *is published four times per year for the community of educators. Recommendations are solicited from readers, and should be addressed to the Education Services Branch, Public Affairs Division (LFC-9), National Aeronautics and Space Administration, Washington, DC 20546. Photocopying for school use is approved.*

Muriel M. Thorne, Editor

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Report to Educators

Explorer 1

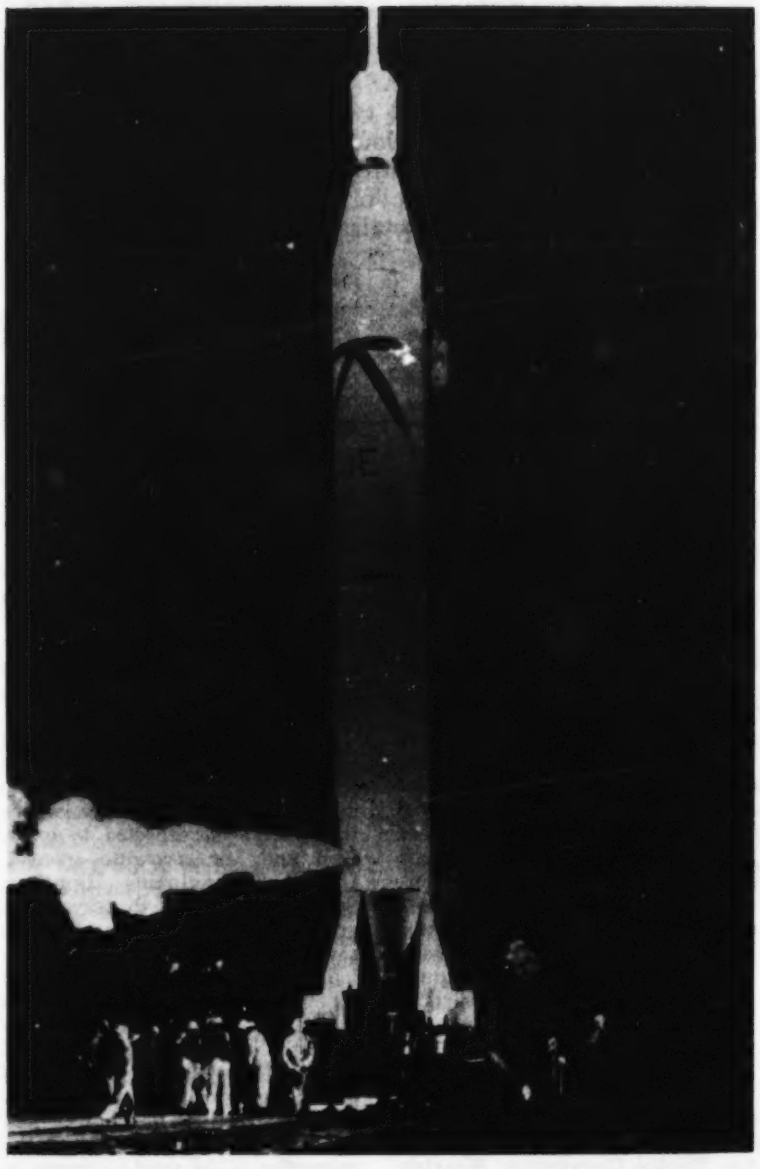
At 10:48 p.m. EST, January 31, 1958, the United States launched its first artificial satellite. Named Explorer, the scientific satellite fulfilled America's commitment to the International Geophysical Year (IGY). The scientific program of the IGY included a proposal to launch satellites that would measure the Earth from space. Russia orbited Sputnik 1 on October 4, 1957, and the United States, Explorer, four months later.

Explorer 1 was a 14-kilogram stainless steel cylinder 15.2 centimeters in diameter and 203 centimeters long; it contained two micrometeoroid detectors and a geiger counter for the study of energetic particles. It transmitted information until May 23, 1958. Orbiting the Earth once every 115 minutes, it remained in orbit until 1970.

Launched by the Army, the IGY satellite program was transferred to NASA when the new agency was formed in October 1958. Its first Explorer was number 6.

Explorer 1 spawned a program of marvelous variety. The name was kept for a series of small scientific satellites. In more than 50 missions they have studied Earth's shape and surface, near-Earth space and interplanetary space, and astronomical and astrophysical phenomena; have included applications satellites; and have been related to space technology programs.

Explorer 1 seems elementary compared to its sophisticated followers. But it was the first. And its small package of instruments produced the first major discovery of the Space Age, the Van Allen radiation belts.



January 31, 1958. The Jupiter-C rocket on the launch pad at Cape Canaveral prior to launching Explorer 1.

NAS1.49:

Space Shuttle

STS-6

A test firing in December 1982 of the Space Shuttle orbiter *Challenger's* main propulsion system revealed the presence of a high level of gaseous hydrogen in the spacecraft's aft compartment. A review of the data resulted in a second on-the-pad test firing in January. Technicians continue to investigate still-present hydrogen concentrations and a new launch date for STS-6 (Space Transportation System) will probably fall sometime in March.

The mission will deploy NASA's Tracking and Data Relay Satellite, one of an eventual two-satellite system that will provide more comprehensive voice and data coverage between ground and orbiting Space Shuttles. The crew is Paul J. Weitz, commander; Karol J. Bobko, pilot; Donald H. Peterson and Dr. Story Musgrave, mission specialists.

STS-5

SSIP experiments. The *Columbia's* fifth flight in November 1982 was the third to carry experiments developed by high school students as part of the Shuttle Student Involvement Project (SSIP).

Three SSIP experiments were performed by mission specialist Joseph Allen during the fourth day of the flight—bringing to six the number of student experiments that have been completed on the Shuttle.

The study of convection liquid flows driven by surface tension was the subject of **D. Scott Thomas'** experiment. In space the effects of forces such as surface tension on liquid flows can be studied exclusive of the effects of gravity. An understanding of these effects is vital to the budding space processing industry.

The experiment was contained in two boxes, a control box and a pan assembly. The pan assembly contained seven pans with self-contained heaters. The control box supported 11 syringes filled with Krytox oil, in which aluminum powder was suspended for flow visualization. To activate the experiment, Allen injected the oil into the heated pans and switched on a video tape camera to observe the results.

Thomas and his corporate sponsor, Thiokol Corporation, Wasatch (UT) Division, are reviewing the tapes and have had discussions with Allen to determine if convection did occur. Thomas was a junior at Richland Senior High School, Johnstown, PA, when he was named an SSIP winner. He is now studying physics at Utah State University.

Michelle Issel, a freshman at American University, prepared an experiment to evaluate the growth of triglycine sulfate crystals free from the effect of gravity. Such crystals are used on satellites to detect light waves in the infrared or invisible spectrum, allowing the detection of heat-emitting sources such as stars or microorganisms that may not be visible.

Preliminary findings from the experiment show that a triglycine sulfate crystal did grow during the flight, but not in the area where they had been expected to grow. Issel and her corporate sponsor, United Technologies Hamilton Standard, expected the crystal to grow on a cold sting tip on which the seed crystal had been placed prior to launch; however, the crystal cluster was found on the screen surface separating the saturated solution from the solute cavity. Issel and scientists at Hamilton Standard plan to analyze the crystals using X-ray defraction techniques and possibly other means by which the properties of the crystals grown in space will be compared to the properties of those on Earth.

Issel was a junior at Mark T. Sheehan High School in Wallingford, CT, when she entered the competition.

In their natural Earth habitat, separated Redbeard sponge cells will communicate with each other and reform into their original sponge shape as long as there is calcium and magnesium present in their seawater world. **Aaron Gillette,** a freshman at Western Carolina University, devised an experiment to test the ability of the Redbeard sponge, *Microciona prolifera,* to reaggregate in microgravity during a space flight. His experiment tested the hypothesis that pressure ratios influenced the intercellular communication necessary for disassociated cells to reaggregate to reform new sponges.

Prior to launch, Gillette and corporate sponsor Martin Marietta Aerospace, Orlando Division, broke sponge cells in a slurry solution in which the calcium and magnesium ions had been removed. The experiment was performed in 18 specimen bags stored in a locker aboard the *Columbia.* During the mission, Allen released the calcium and magnesium ions into the sponge slurry so the reaggregation process could begin. In some of the samples, a fixative was released to stop the reaggregation process.

Preliminary observations of the returned bags indicate that reaggregation did occur for both the ground control and Shuttle-flown experiments. Both were smaller aggregations than previously observed during a similar time frame. Preliminary scanning by electron microscopy indicate that more connected tissues were produced in space than on the ground. Analysis of the samples is now being conducted by Gillette, his sponsor, and by scientists at three medical schools.

Gillette was a junior at Winter Haven Senior High School (FL) when he proposed his experiment.

The SSIP is a joint effort of NASA and the National Science Teachers Association. Winners of the third SSIP competition will be announced in May 1983.

Michelle Issel, student experimenter, explains her experiment to STS-5 crew members Joseph P. Allen, mission specialist (left), and Vance D. Brand, commander (right).

STS-7 and STS-8 Crews

Fifth crewmembers have been named for Shuttle flights STS-7, Dr. Norman Thagard, and STS-8, Dr. William Thornton. Both physicians, Drs. Thagard and Thornton have been added to assist in accomplishment of additional mission objectives. Neither has flown in space.

They will conduct medical tests to collect data on several physiological changes that are associated with the space adaptation syndrome. The tests will focus on the neurological system and are a continuation of the new approach to making inflight measurements that began on STS-4.

These efforts are directed toward initiation of an inflight search for countermeasures and to provide a more complete understanding of the space adaptation syndrome.

STS-7. Thagard will join commander Robert L. Crippen, pilot Frederick H. Hauck, and mission specialists John M. Fabian and Dr. Sally K. Ride. The STS-7 payloads will be a German Shuttle pallet satellite (SPAS), the second Office of Space and Terrestrial Applications instrument package (OSTA-2), a Canadian communications satellite (Telesat F), and an Indonesian communications satellite (PALAPA-81).

STS-8. Thornton will join STS-8 commander Richard H. Truly, pilot Daniel C. Brandenstein, and mission specialists Dale A. Gardner and Guion S. Bluford, Jr. The payloads will be an Indian communications satellite (INSAT 1-B) and NASA's Tracking and Data Relay Satellite (TDRS-B), the second and final element in the TDRS System.

STS-9

The first flight of Spacelab, now scheduled on STS-9, the joint project between NASA and the European Space Agency (ESA), is scheduled for launch in late 1983. Mission commander for the seven-day flight is to be John W. Young and pilot will be Brewster H. Shaw, Jr. Mission specialists will be Drs. Owen K. Garriott and Robert A. Parker.

Australian Payload Specialist

Australia is the first country to announce formally the intention to fly a payload specialist on the Space Shuttle. The Australian payload specialist will fly on one of two 1985 Shuttle flights—July or October—on which space has been reserved for the launch of communications satellites by AUSSAT Pty., Ltd., operator of Australia's national satellite system.

Australia is accepting NASA's newly enhanced policy which expands opportunities for sponsors of payloads on the Shuttle to fly their own personnel. Under the revised policy, major payload sponsors will have the opportunity to nominate payload specialists to accompany their payloads into space. Training and flight of these payload specialists will normally be on a reimbursable basis, although other arrangements may be negotiated in the case of cooperative flight projects involving the Shuttle.

The Australian Department of Science and Technology will be responsible for the selection of the astronauts and other arrangements, in association with AUSSAT. The department is also responsible for the operation of Australian telecommunications systems using satellites.

The two Australian satellites called AUSSAT, will be used for direct television, broadcast, voice, data, and public telephone services to continental Australia and offshore territories.

GTE

The GTE Satellite Corp. will use the Shuttle to launch its GSTAR-C communications satellite in May 1985.

GSTAR-C will be used to provide common carrier communication services to users in the continental United States, Alaska, and Hawaii. The satellite will use the Payload Assist Module to achieve geosynchronous orbit.

Landsat 4 Results

Landsat 4 returned its first images on July 19 and 20, 1982, and surpassed all expectations. From its 694-kilometer orbit it is providing farmers, geologists, and environmentalists with extraordinary information: once difficult to differentiate crops are distinguishable, as are snow and clouds; variation in clay minerals can be mapped; urban features in large metropolitan areas are clearly delineated; and for the first time from a Landsat spacecraft, natural color images of the Earth's surface features have been obtained.

The First Landsats

Landsat 4, launched last July 16 from the Western Space and Missile Center, began operation just ten years after the first of the series. Landsat 1 was followed by Landsat 2 in 1975 and Landsat 3 in 1978.

These first Landsats carried an Earth-viewing sensor known as the Multispectral Scanner (MSS) which obtains imagery of the Earth's surface in four discrete spectral (light) bands. The decade of their image-collecting showed the unique types of data that MSS imagery could provide for geology, agriculture, urban studies, forestry, water management. The images that Landsats 1, 2, and 3 collected represent the first historical record of Earth's global surface conditions. Landsat 4's instruments are expanding greatly their routine observations.

In addition to the MSS sensor, Landsat 4 has a new sensor, the Thematic Mapper (TM), which is far more sophisticated.

Thematic Mapper

The TM measures the intensity of surface radiation in seven discrete spectral bands (six are sensitive to variations in reflected sunlight and the seventh, commonly referred to as the "thermal band," is sensitive to surface temperature).

Individual picture elements, "pixels," in a TM image cover an area of 30 × 30 meters, except for the thermal band which has a spatial resolution of 120 × 120 meters. Each spectral band of the TM has a range of 256 gray levels compared to the less sensitive MSS with an overall range of 64 gray levels in each band. The TM has approximately twice the spectral resolution, three times the spatial resolution, and four times the sensitivity of the earlier MSS sensors.

More than 100 TM images have been fully processed with the following results.

Agriculture. The TM bands were selected in part for classifying crops and monitoring conditions. Analysis of a scene that encompassed a wide variety of crops showed that several of the new spectral bands are especially useful for distinguishing crops such as rice and soybeans, which are difficult to differentiate in MSS imagery. Early results also suggest that a TM image acquired at a single point in time may achieve the same accuracy in crop classification that has been achieved with multiple MSS images obtained throughout the entire growing season. The improved spatial resolution of the TM is particularly useful for crop assessment because a greater number of the TM pixels fall within individual fields; pixels in single fields produce a more accurate measurement of the spectral characteristics of individual crops than do "mixed pixels" which straddle field boundaries and contain spectral signatures of roads and trees as well as crops.

Geology. One of the major factors in selecting the TM spectral bands was the wish of geologists to map variations in the abundance of clay minerals in semi-arid regions.

Initial gelogical evaluation of TM data has shown that mineralogical variations between major classes of rocks such as granites, quartzites, and volcanic lavas can be detected clearly. Studies comparing airborne TM and Landsat TM imagery also show that mineral evaluation studies can be conducted routinely in semi-arid regions over areas of 185 × 185 kilometers or greater.

Water resources. The improved spatial resolution of the TM will lead to better mapping of natural watersheds, estimates of urban runoff, and management of storm water in metropolitan areas. Nutrients and sediments commonly found in coastal waters can be more accurately differentiated with TM data; preliminary analysis of data acquired over the coastline near Charleston has demonstrated that suspended sediments can be distinguished from plankton in near-shore waters. The data should be useful for longer term studies of topsoil erosion and sediment transport in coastal environments, for monitoring soil moisture conditions and evaluating the effectiveness of crop irrigation practices and for detecting water stress conditions in both natural and cultivated areas.

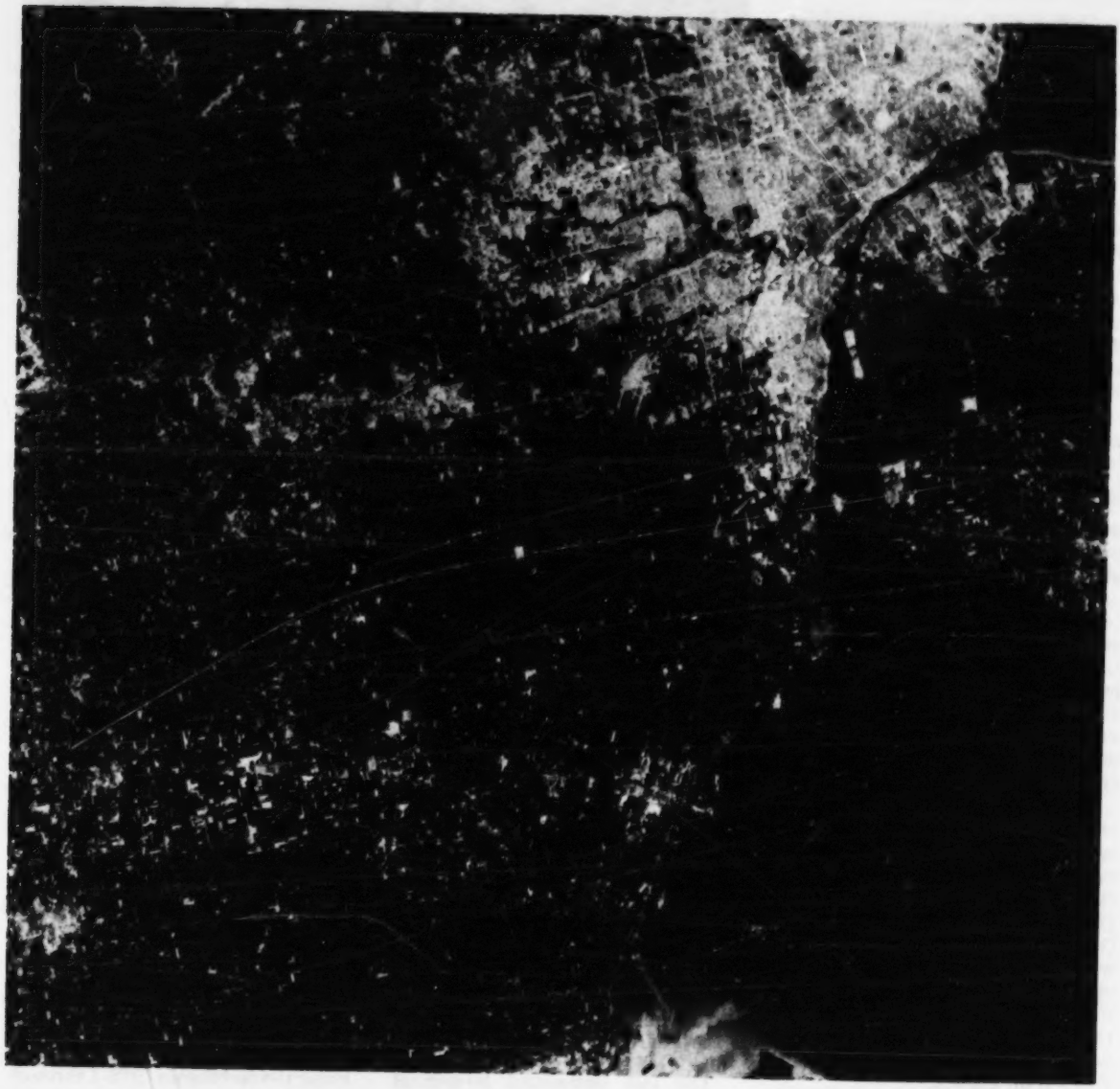
Urban Studies/Land Use Planning. The TM can identify surface features such as individual buildings and landmarks. It can distinguish highway construction material, land excavation, and the health of vegetation.

NOAA

NASA has transferred the operation and management of the Landsat system to the National Oceanic and Atmospheric Administration (NOAA). Landsats 1 and 2 are no longer operational. Landsat 3 will be retired later this year.

NASA will retain management control over the TM during the experimental research and development phase of the new sensor system and expects to transfer control of the TM to NOAA in early 1985.

Landsat imagery is available to the public at a lab service charge. For information about ordering pictures, write to the EROS Data Center, Sioux Falls, SD 57198.



The first image from Landsat 4's Thematic Mapper. The resultant image (185 km × 185 km) is a composite of three individual images from detectors in the green, red, and infrared portions of the spectrum. In this quadrant section enlargement of the image, nearly all of Detroit, Michigan, and the northern parts of Toledo, Ohio, are clearly visible in the top and bottom portions of the picture, respectively. The body of water in the lower right is Lake Erie; in the upper right, Lake St. Clair. In the lower outskirts of Detroit, near the center of the picture, the Detroit Metropolitan Wayne County Airport is visible and to its immediate left (west) is the Willow Run Airport.

1983 Launch Schedule

On January 25 the first launch of the year will be the lift-off of NASA's Delta vehicle from the Western Space and Missile Center (WSMC) in California to place the Infrared Astronomy Satellite (IRAS) into a near-polar orbit. After check-out of the spacecraft and its infrared telescope, the international satellite will begin a seven-month survey of the sky.

The IRAS launch begins a busy year for launch teams throughout the NASA system: five scheduled Space Shuttle operational flights and several unmanned missions.

In March, from the Eastern Space and Missile Center (ESMC) in Florida, an Atlas Centaur will boost the Intelsat V-F into orbit for the International Telecommunications Organization and a Delta will put the RCA-F into orbit; from WSMC, the NOAA-E will be launched aboard an Atlas rocket with a payload including search and rescue instruments developed by Canada and France that will join the Soviet Union's COSPAS to form an experimental international satellite-aided search and rescue system.

April will have a Delta to launch NOAA's GOES-F, Geostationary Operational Environmental Satellite; May, a Scout to launch the San Marco-D/L, an international cooperative project with Italy, from the San Marco Range in the Indian Ocean; June, a Delta to launch the Hughes communication satellite, Galaxy-A, from ESMC; and July will have a Scout to put the Navy-21 into orbit for the Department of Defense (DOD) from WSMC and a Delta to hoist TELSTAR-3A aloft for American Telephone & Telegraph from ESMC.

August will have three missions: a DOD payload designated AF-1 (ITV) using a Scout for launch from the Wallops Flight Facility in Virginia; NOAA-E, a weather satellite, using an Atlas, from WSMC; and the RCA-G using a Delta from ESMC. September is the scheduled month for the Hughes communications satellite, Galaxy-B, and October for the military communications satellite NATO III-D; both will be launched from ESMC using Delta rockets.

The DOD has scheduled November for Navy-22 from WSMC and the Air Force and December for its satellite AF-2 from the Wallops facility; both will use a Scout.

The last unmanned launch of 1983 is now listed as an Atlas Centaur carrying Intelsat VA-A from ESMC.

Artist's concept of IRAS in Earth orbit.

For the Teacher

1. Have your students watch for news of coming launches and follow their development. Have them research the payloads: owners, purposes, users.

2. What are the advantages of geostationary orbits? polar orbits? elliptical orbits?

3. What types of satellites use geostationary orbits? What other uses would profit by these orbits?

4. Have your class keep a file on the Space Shuttle flights, researching the test flights (STS-1 through 4) and comparing the operational flights—their crews, payloads, and missions. How did STS-5 differ from the first four flights? How will future operational flights differ?

5. Divide your class into groups and have each research a different facet of NASA's international programs—cooperative payloads, reimbursable launches, number of countries participating.

Aerospace Congresses

NCAE

Educators will gather in Las Vegas, Nevada, April 7-9, for the 1983 National Congress on Aerospace Education (NCAE). Sponsored by the National Air and Space Museum, CAP, FAA, and NASA, the Congress is designed for everyone interested in aerospace education. The program will feature nationally known speakers on space issues, aerospace experiences for the classroom, and an update on the Space Transportation Syatem by Dr. Joseph P. Allen, STS-5 mission specialist. A highlight will be the presentation of the Crown Circle Awards for Aerospace Education.

WAEO

The Third Biennial World Congress on Aerospace Education (WAEO) will be held in Washington, D.C., July 10-15, 1983. The theme, "Aviation and Space Education in Service to Mankind," will be expressed in a variety of subjects by several speakers: Dr. Hans Mark, Deputy Administrator, NASA; Dr. Terrel H. Bell, Secretary of Education; Erik Quistgaard of Denmark, Director General of the European Space Agency; and Dr. Umberto Nardio, Chairman, Alitalia.

The Capitol Holiday Inn, one block from the National Air and Space Museum, is the World Congress 83 Headquarters Hotel. Rates: $55, single; $65, double. Preregistration fee mailed before May 10, 1983 is $100; after May 10, the registration fee is $130. Mail to: Curtis M. Graves, Secretary General, W.A.E.O., 8004 16th Street, NW., Washington, DC 20012.

Education News

From the Jet Propulsion Laboratory

In June 1982 **Benito Casados** resigned from his position as Manager of Education and Community Relations at NASA's Jet Propulsion Laboratory in Pasadena to become Vice President for Educational Programs with Video Vision Associates.

Casados had been with NASA's education services for 18 years as Aerospace Specialist and Educational Programs Officer. His contributions to aerospace education were many and in his new position he continues his involvement through the emerging technology of the videodisc.

Philipp D. Neuhauser was appointed Manager of JPL's Audiovisual and Education Office last June when the Audiovisual Communication and Education and Community Relations offices were combined. His responsibilities include JPL's audiovisual productions, services, and facilities as well as dissemination of the Laboratory's and NASA scientific findings to educational institutions and the general public. He also coordinates JPL artifacts and exhibits with the National Air and Space Museum in Washington, D.C.

Neuhauser had served as Manager of the Audiovisual Communication Office since 1968. He and his staff produced live television broadcasts from JPL which were distributed to commercial network, local, public, and cable television broadcasters.

He joined JPL in 1962 as an audiovisual specialist for the Deep Space Network and has participated in all JPL missions from the Ranger missions to the Moon to the current Voyager missions to Jupiter, Saturn, and Uranus. He has been executive producer of several multimedia productions since 1969, including NASA's U.S. Bicentennial presentation "NASA: The Next 100 Years in Space."

Neuhauser holds memberships in several professional organizations and has authored articles for technical publications and journals. He has been an instructor of audiovisual communication at Pasadena City College for over 15 years, is a curriculum advisor for the Pasadena City School District, and has served as a guest lecturer to various universities.

Before joining JPL, Neuhauser was writer-director-producer of industrial documentary motion pictures for General Dynamics Convair Division. A native of Brooklyn, NY, he received his bachelor's degree in journalism from Woodbury College in Los Angeles and has had additional studies at Occidental College, Los Angeles and UCLA.

Publications

Space Telescope, EP-166, is a 64-page booklet that details the telescope's capability, what it is expected to see in space, and its impact on science and human thought. Scheduled for launch into Earth orbit in 1985, the telescope will be able to see objects 50 times fainter and seven times farther away than any ground observatory. Paperbound, 64 pp., $5.50. (Stock No. 033-000-00862-7.)

Available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Experimental Results: Insect Flight Observation at Zero Gravity, is an NSTA-NASA Shuttle Student Involvement Project report written by Todd E. Nelson, the student experimenter, and James R. Peterson of Honeywell, Inc., corporate sponsor. Single copies may be requested from Alan M. Ladwig, Customer Services, Office of Space Flight (MCS-7), NASA, Washington, DC 20546.

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Where to Write for Services

Publication lists, film lists, and information about other services are available from the Education Services office at the NASA center serving your state. See the list below. There are special resource centers for educators at the Kennedy Space Center, Lewis Research Center, and Alabama Space and Rocket Center (Huntsville, AL 35807).

NASA Ames Research Center
Moffet Field, CA 94035
Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

NASA Goddard Space Flight Center
Greenbelt, MD 20771
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

NASA Lyndon B. Johnson Space Center
Houston, TX 77058
Colorado, Kansas, Nebraska, New Mexico, N. Dakota, Oklahoma, S. Dakota, Texas

NASA John F. Kennedy Space Center
Kennedy Space Center, FL 32899
Florida, Georgia, Puerto Rico, Virgin Islands

NASA Langley Research Center
Hampton, VA 23665
Kentucky, N. Carolina, S. Carolina, Virginia, West Virginia

NASA Lewis Research Center
Cleveland, OH 44135
Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

NASA George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812
Alabama, Arkansas, Iowa, Louisiana, Mississippi, Missouri, Tennessee

The Administrator of the National Aeronautics and Space Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through December 31, 1984.

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Muriel M. Thorne, Editor

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